THE PROBLEM OF SHIFTING CULTIVATION

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(G/214/I.S.—Aboriginal tribes in the Eastern States practise shifting cultivation, an important factor for their backwardness. The remedy is to persuade the aboriginal to settle down to permanent cultivation. A successful attempt of the kind was made at Girishchandrapur in Rairakhol state. Details of work in other states follow.

A possible danger is indebtedness to outsiders. Wet cultivation may support four times the population possible with shifting cultivation. Propagation of bamboo is suggested to speed up rehabilitation of the ruined forest. Details of the scheme are given, with suggestions for improvement. 11 factors essential to its success are stated).

There are several aboriginal tribes inhabiting parts of some of the Eastern States; all of them practise shifting cultivation and only here and there have any of them taken to permanent cultivation. For many years shifting cultivation in India has been viewed with apprehension by those with sufficient vision to appreciate the ultimate harmful

effects of the practice. Attempts have been made by administrators and forest officers to tackle the problem but, with few exceptions, there has been no progress.

It is difficult enough anywhere to get hillmen to change their ancient customs; it is even more difficult in the case of aboriginals for shifting cultivation is, as is the case with most of their customs, part of their religion and is a tribal rather than a personal matter. But the degree of religious prejudice and of tribalism varies and the Maria Gonds of Bastar State, referred to later, are an example. Another difficulty, which may be greater in other parts of India, is the opportunity to find suitable land in the vicinity of the tribal home on which to establish permanent cultivation.

Generally speaking, aboriginals are backward and primitive peoples living at peace in the jungles and there is a school of thought which favours leaving them alone in their primitive condition; on the other hand, there are those who wish to impove their lot and to make them, if possible, useful citizens. As far as the Eastern States are concerned, I feel sure from what I have seen and have been told during my tour that the only course to take is to try and reclaim the aboriginals; for here they are for the most part not sufficiently far removed from civilisation to avoid becoming a prey sooner or later to various exploiting agencies from the country outside their boundaries. This in fact has already taken place in several aboriginal tracts which I have seen during my tour and it is a situation which is likely to be aggravated when whole tracts of the Agency are further opened up by rail and road as they shortly will be. It would, in my opinion, be misplaced kindness to seal off the tribes, no matter which they are, and to attempt to improve their condition *without* changing their system of cultivation; for shifting cultivation is one of the most important factors which keeps them in their primitive condition.

Sal forest is favoured above all other types for shifting cultivation, and with repeated clearances and burnings, *sal* disappears altogether and the land goes over to bamboos or useless shrubs, but if the practice is stopped in time, a fine crop of evenaged *sal* will result. I saw numerous examples of such crops resulting from reservations made 20—40 years ago. The value of the land as cultivation also depreciates with each succeeding clearance; all aboriginals admit this.

The cultivator usually crops a site for 2-3 years but returns to it after varying periods; the rotation may have been as much as 30 years some time ago, but in most of the places I visited it is now 8 to 10 years. The shorter the rotation the more rapid is the deterioration of the vegetation and the soil.

There are thus two reasons for attempting to stop the practice of shifting cultivation; the first is to prevent the ultimate destruction of the forests and second is to raise the standard of living of the aboriginals and so prevent them from falling a prey to the various human parasites which take advantage of their ignorance.

A crude policy of wholesale reservation with the sole object of preserving the forests would only have the effect of prejudicing any chance of succeeding with the second object; to try to reform the tribes without inducing them to give up shifting cultivation would be to bypass their chief weakness. What is required, therefore, is a combination of the two. If the aboriginal can be persuaded and taught to settle down to permanent cultivation it will be possible to reserve the forests while he himself will establish that permanent association with the land which is the foundation of a higher standard of living; then he will be able to absorb the advance of civilisation instead of his being absorbed by it.

The problem therefore is a two-pointed one, to persuade the aboriginals to give up shifting cultivation on the hills and to find land which would be suitable for permanent cultivation. The first steps in this direction were taken by the Chief Forest Adviser about eight years ago when, assisted by the Dewan and State Forest Officer, he persuaded 83 families of the Kondh tribe in Rairakhol State to settle in a colony on waste land suitable for permanent cultivation at the foot of their ancestral hills. A number of inducements had to be given which included the provision of ploughs; one bullock per house was provided free and the villagers combined to do one another's ploughing and subsequently, as funds were available, every house was provided with one pair of bullocks free. Assistance was also

given by the State for the construction of a *bund* and the digging of a canal to provide a permanent supply of water for the irrigation of the paddy crop; other amenities provided were a dispensary with a compounder and nurse and an agricultural *kamdar* to instruct the Kondhs in improved methods of cultivation and in vegetable gardening. A Primary School was opened which is shortly to be raised to the VI standard. Girls are now attending the school and are taught along with the boys. The total cost of the colony up to the present is Rs. 18,000/- and it has, except for the school, been financed entirely from the forest budget. As regards returns, from next year land rent to the amount of some Rs. 600/- will be forthcoming annually while the reservation of 10,000 acres of forest evacuated by the Kondhs is now giving the State an annual income of Rs. 1,400/- from the sale of bamboos. The village, Girishchandrapur, is neat and well kept, the people seem happy and contented and are growing fruits and vegetables in the gardens round about their houses. None of these erstwhile aboriginals wish to return to their former life; this should be sufficient proof of the soundness of the policy.

In the larger State of Bamra similar achievements are well on their way to realisation. In this State there are two tribes, Bhuinyas and Kondhs, numbering 618 families with a population of about 4,000 which have practised shifting cultivation on an area of about 150 square miles. They live mainly in hamlets dotted about in the forest but a few of them have small areas of "wet" (paddy) and "dry" cultivation of a permanent nature. In this case the Raja himself took a keen interest in the scheme and personally visited the villages to make it a success. Conditions here were different from those at Girishchandrapur and in this scheme both tribes were permitted to stay on in their ancestral villages where sufficient land suitable for permanent cultivation, both "wet" and "dry" was available in the vicinity of the hamlets. These new settlements were demarcated on the ground and they also included adequate land for grazing and forest for the villagers' needs. Some area was also provided for shifting cultivation within each demarcation but at the end of four years this land was exhausted and shifting cultivation on it was automatically given up.

Other features were:—

(*i*) wherever there was insufficient land for permanent cultivation in the ancestral village, additional cultivable land was provided in neighbouring villages at the foot of the hills, with a rent remission varying from three to five years;

(*ii*) plough cattle, paddy seed, agricultural implements, house building timber were provided free;

(*iii*) a fund to provide free grants for the construction of *bunds* and other works necessary for the irrigation of the paddy land has been created by the State;

(*iv*) a loan of paddy was given while the new lands were being built up.

I toured through some of these villages and was struck by the amount of work in progress on the establishment of permanent "wet" cultivation.

In this area settlement has already permitted the reservation of some 60 square miles of forest which, apart from the income it will eventually bring in from bamboos and timber, will ensure the safety of the fertile Reamal Pargana lying below which would be threatened by destruction from torrents if the forests were destroyed by shifting cultivation.

Across the Brahmani river in the same State of Bamra I saw another settlement of Bhuinyas in its early stages. The general plan here was more like that of Girishchandrapur and the State had undertaken to construct a reservoir to provide water for irrigation.

In the State of Pal-Lahara I visited another village where settlement was just beginning; here many of the villagers were still up in the hills reaping the final crop from shifting cultivation for this was not to be stopped until the permanent land was ready for cultivation.

In this State there is another tribe, probably the most primitive, called Juangs. Many years ago they had been turned off the hills in which they had practised shifting cultivation and had come down to live a miserable existence as the serfs of more prosperous villagers in the valleys. They are now being collected and brought together in a colony where they will again have their own land for cultivation.

The next State visited was Keonjhar; here also are Bhuinyas and Juangs. The area covered by shifting cultivation in this State is some 500 square miles, or 300,000 acres, and over a large area the forest has been completely destroyed and the soil itself is becoming exhausted; shifting cultivation is in practice from hill-top to valley, covering an altitude of nearly 3,000 feet. The problem is a big one here and the Chief Forest Adviser has quite rightly advised the Darbar to divide the whole tract up into a number of projects which will be taken up in turn. One of the chief difficulties here is that much of the good land in the valleys has since long time been usurped by cultivators from outside and this has, no doubt, prevented some of the aboriginals from taking to wet or permanent cultivation on their own. There is, however, a good deal of permanently cultivable land both on the uplands and in the valleys which can be brought under "wet" cultivation by irrigation schemes which will tap the streams which are numerous. Some of these irrigation schemes will be ambitious and the canal in the first scheme will cost about Rs. 12,000/-; the survey has already been started by the Forest Department. It has been decided by the Darbar that settlement operations will be undertaken by the Forest Department on the higher slopes and by the Agricultural Department on the lower ones though in the latter case forest which will be released for reservation after settlement of the villagers in the new colonies will be taken over by the Forest Department. I have referred above to the invasion of outsiders; the Chief Forest Adviser has recommended that no more should be allowed to settle in this tract and that those who have settled within the last five years should be compensated and moved elsewhere. They are apparently turbulent and aggressive people and would soon get the Bhuinyas into their clutches through debt and so acquire their newly reclaimed land; if this were to happen, the whole scheme would fail.

Although the total cost of converting 300,000 acres of shifting cultivation into permanent settlement will be considerable, the State will benefit directly from the increased land values; it is estimated that the "wet" cultivation to be reclaimed in the first project will be able to support a population four times as great as that which barely exists now on the shifting cultivation. In addition the forest will in course of time become productive; and in order to speed this up I suggest the propagation of bamboo.

In this scheme the system adopted in fixing a colony or settlement is to assume that each family consists of 5 members (aboriginals do not have very large families), allot 5-6 acres of "wet" land and two acres of "dry" land to each family. The Chief Forest Adviser insists quite rightly that holdings should not be fragmentary.

In the Keonjhar schemes the tract, will after settlement, be covered by the following land uses :—

(1) Reserve "A" forest. Commercial or protection forest.

(2) Reserve "B" forest. For satisfaction of villagers' requirements, and for protection; grazing allowed on payment of fees.

(3) *Gochar*, or village grazing land.

(4) Wet land, paddy cultivation.

(5) Dry cultivation, cultivable land uncommanded by irrigation.

Both categories of forest will come under working plans.

Although the movement is in its infancy, the main principles and much of the detail have already been worked out and there is little I can offer in the way of suggestions.

I think it would be a wise precaution when allocating land for a new colony, whether inside or outside the forest, to make an allowance for an increase in the population; this will surely come, and although some of the surplus may become wage-earners not all of it will.

The boundary line of the reserved forest should be kept well back from the habitations and cultivations; cattle cannot be kept from straying and forest guards are quick to take advantage of it.

Dry cultivation can be greatly improved by by cantour ridging or terracing.

At the schools I think all possible emphasis should be laid on vocational training, handicrafts, fruit and vegetable growing, cleanliness, etc. For the girls reading and writing at this early stage is not important.

The Chief Forest Adviser has in certain cases recommended that new settlements should

remain under the forest department and should be administered as forest villages, except that the land rent should be remitted to the revenue department. This, I think, is sound; forest officers are of necessity in close contact with the forest dwellers; they understand their difficulties and so are able to help them in many ways, including the finding of work for them.

Factors found to be essential to success are :—

(*i*) Tactful, persistent persuasion, of the villagers, no compulsion; the aboriginal must be made to understand that everything that is being done is in his own interest.

(*ii*) Appointment of a special officer, who can be relied upon for (i) and who will stay on the job until completed; he must understand the scheme thoroughly.

(*iii*) Adoption of a general policy which should subsequently undergo as little change as possible.

(*iv*) The colony must be near the hill in which the spirits of the ancestors dwell.

(*v*) If possible, medical aid in the form of a dispensary.

(*vi*) The promise of ultimate title in the new land.

(*vii*) Aid in the form of bullocks, grain, etc. construction of *bunds*, minor canals, seed grain, etc.

(*viii*) Unrestricted right to roam the forests for roots, fruits, honey, etc., which have always formed an important part of the aboriginals' livelihood.

(*ix*) Remission of rent for a short period on reclaimed land.

(*x*) Money-lenders, liquor sellers and other human parasites must be banished or prevented from entering settlements.

(*xi*) Finally and most important, legislation to prevent the alienation of land.

To what extent the experience gained in the Eastern States can be applied in other parts of the country, I cannot say. At any rate, a way has been shown, and although in the Eastern States there may be one or two favourable factors not found elsewhere, it has been demonstrated that the aboriginal can be persuaded to give up shifting cultivation.

I would not suggest that all cases should be treated alike; obviously a slower approach would be made in the case of the more primitive tribes or those which are more remote from cultivation. But in these States, at any rate, there is nothing in favour of the practice and everything against it. Its disadvantages to the people who practise it and to the State have already been discussed. Taking the widest view of the case, owing to the clearance of hundreds of thousands of acres of forest, India is being deprived of various classes of forest produce which will be badly needed for a long time, and a large contribution to the flooding and silting of rivers is being made. To sum up, I consider that nothing should be allowed to stand in the way of the banishment of shifting cultivation from all the States.

A LITTLE-KNOWN BURMESE BAMBOO

By M. B. Raizada

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(G/0472/R.I., G/1121/R.I., S/O/.R.I.—Bambusa copelandi, page 671 of Indian Trees by D. Brandis, 1921, is largely cultivated in the Northern Shan States, and is a large species. It was stated to have an uncertain position in the genus Bambusa. Details of interesting correspondence preserved at Dehra Dun are given. The bamboo flowered in 1896 in the Shan States. Clumps raised from the seed at Dehra Dun flowered at the end of November, 1943. This species has been named as "Sinocalamus copelandi" now and described, with plate. This genus is meant to include several Chinese bamboos, which are apparently intermediate between "Dendrocalamus" and "Bambusa").

The bamboo *Bambusa copelandi* Gamble ex Brandis about which very little is known was first described in Brandis *Indian Trees* (1911) 671, where it is stated that it is of uncertain position in the genus. E. G. Camus in *Les Bambusee* (1913) 127, and E. Blatter in his article 'The Indian Bamboos brought up to date' which appeared in the *Indian Forester* LV (1929) 541 *et seq.* knew no more of *B. copelandi* than what is stated in *Indian Trees*. It is therefore desirable to place on record all available information on this species.

History

According to a letter (preserved in the Dehra Dun herbarium) dated the 12th April 1923 from J. S. Gamble to R. N. Parker, formerly Forest Botanist, Forest Research Institute, Dehra Dun, the history of the plant is this. On June 10, 1896 J. W. Oliver wrote to me from Mandalay: " I enclose a few seeds of a species of bamboo called "Wagyi" which, according to Copeland, resembles "Wani"—*Dendrocalamus latiflorus* in general appearance and is largely cultivated in the Northern Shan States. Copeland has collected a large quantity of the seed which I am sending you in a separate parcel. The seeds are not like anything I have seen before."

"We sowed nearly the whole of the seed in the school garden. It germinated well and before I left Dehra in 1899 I had moved plants to various places such as Roderick house etc. I only kept a few seeds—caryopses—and I have discovered one which I am sending you herewith, you can keep it. You will see that Oliver was quite right, it is like nothing else that I know but it certainly cannot be a *Dendrocalamus*. I tried *Gigantochloa* but the stamens are not monadelphous. It seemed to me nearest to *Thyrsostachys*, being obviously a 'Bambuseae', and when I lent specimens to Brandis I thought it best simply to call it *Bambusa copelandi*, the intention being to call almost every thing *Bambusa* until the real genus is conclusively discovered. In some of the spikelets I dissected, I found the palea a good deal cleft at the tip and that also pointed to *Thyrsostachys*."

"I tried a good deal of it, the young leaves and sheaths, in 1898, and Mian Birbal sent me some more specimens in 1901. I fancy I put specimens in the school herbarium, if not, let me know and I will send you out one or two sheets, they do not match anything else I know of. I enclose with the caryopsis a couple of spikelets and the dissections of another showing the stamens with free filaments and the bifid palea. There are 3 fairly large lodicules. Until it flowers, we had better leave it as Brandis described it, *Bambusa copelandi* Gamble ex Brandis in *Indian Trees*. I do not think he had any specimens except the sheets and drawings he borrowed from me. I do not know why he called the sheath hairs black, mine are all golden yellow".

In another letter to Parker dated the 8th August 1923, Gamble while commenting on certain specimens of Troup from Maymyo writes about this bamboo as follows:

"At last, having worried painfully through a host of small *Acanthaceae* I can take a little relaxation and go into the Copelandi case—your D. O. No. 503/85 of 17-5-1923. It is an interesting commentary on the results of collecting through others instead of making sure yourself and the problem is by no means solved yet."

"Troup's specimens from Maymyo, which I return, are as you suggest, *Dendrocalamus*

calostachyus and I am glad to find, after dissecting the spikelets, how accurate my description in the Bambuseae was".

"But I think we must beware of jumping at the conclusion that the bamboo cultivated at Dehra Dun is also *D. calostachyus*. Until it flowers, its name must still remain indefinite or as *Thyrsostachys copelandi?*"

"J. W. Oliver wrote to me from Mandalay, 10-6-1896, sending seeds of "Wagyi" collected by Copeland in the Northern Shan States. These were the bottle-shaped seeds and some of them were in their spikelets, big glabrous over an inch long. The seeds had the characters, I thought, of Bambuseae not Dendrocalameae and the spikelets had several flowers, the lower ones with bifid, the top ones with entire palea, also 3 rather large lodicules. I called the plant *Bambusa copelandi* and told Brandis of it showing him the specimens and he published it. The seeds were grown at Dehra Dun and I send you my little sketch of a seedling, which is I think unmistakable. There were not many plants raised but we put them out in various places especially in the school park and probably at Kaunli. I also put one at least in the garden at Roderick house, and (I think) another on the roadside near the church."

"I think Oliver must have grown it also at Mandalay and when specimens of *B. copelandi* were asked for, Troup and perhaps others took flowers from *Dendrocalamus calostachyus* though I suspect *B. copelandi* has not yet flowered there any more than at Dehra Dun. Nothing more can be done until the Dehra clumps flower. I may have been wrong in thinking the caryopsis was *not Dendrocalamus* for the pericarp is rather thick and loose. One thing, however, can be done and that is, if there is any one in Shan States botanically inclined and accurate enough, to try and trace Copeland's 'Wagyi' of course Wagyi is a name that a cooly would give to any big kind, still, it might be traceable. I am returning your sheets and thank you for those of the culm sheaths of *D. calostachyus*, which I retain."

As stated above this species of bamboo flowered in 1896 in the Northern Shan States, Upper Burma. The seed collected by Copeland was forwarded by J. W. Oliver, I.F.S., Conservator of Forests, to the late Mr. Gamble who at that time was the Director of the Forest School, Dehra Dun. Gamble germinated the seeds and planted the seedlings at various places in Dehra, such as Kaunli and the School Park now known as Forest Park.

All these Dehra clumps started flowering at the end of November 1943, the first indication being the fading of the leaves which soon began to drop off. About the third week of December the large compound panicles of long, whip-like, curved spikes, purplish in colour were quite prominent. By the middle of January the spikelets had completely emerged and the six stamens of two-three topmost florets of spikelet were visible. Seed, however, did not mature till about end of May.

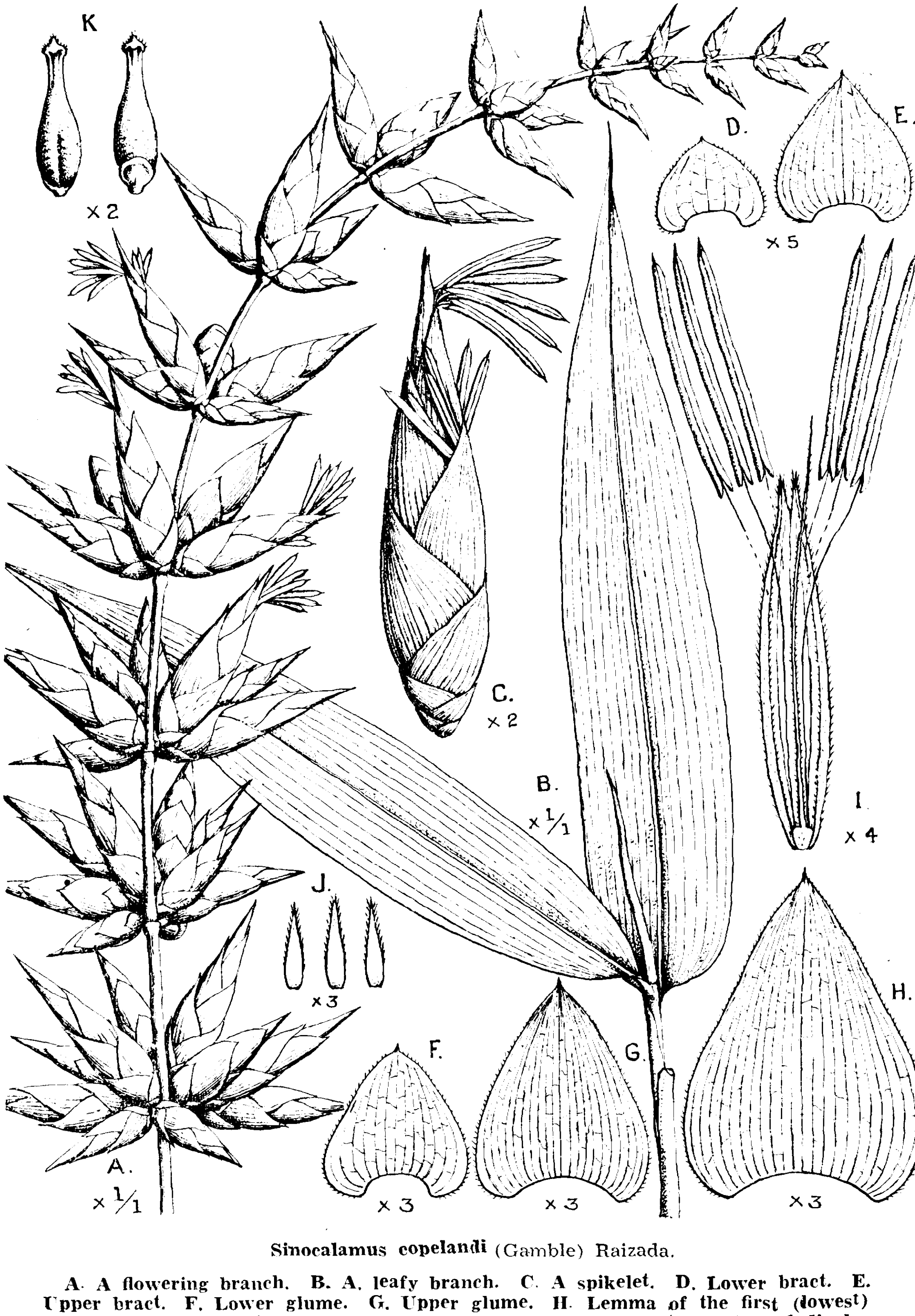
With plentiful fresh material to work upon, it at once became evident that a detailed description of this bamboo was much to be desired as the brief description given by Gamble, prepared from dried material not only required modification in many respects but was inadequate to place the bamboo into its right genus. A lapse of twenty-four hours or so is sufficient enough for the features of the structure of the delicate palea to be lost and no amount of boiling will restore them.

The flowers are protandrous and the stamens are thrust out of the floret long before the stigmas of the same floret appear and are ready to receive the pollen. Although all the florets (except the topmost one) are hermaphrodite, in all the spikelets examined by the writer the fourth or fifth floret only produced a seed. It was observed at the flowering time that the stigmas of the lower two or three florets do not appear at the apex of the florets and are apparently not fertilised at all.

Description

A large, handsome, tufted bamboo. Culms up to 20 m. at Dehra Dun, about 50—60 cm. in circumference at the base, walls fairly thick at the base (walls 2.5 cm. cavity 8 cm.); nodes hardly prominent; internodes narrow at the base, gradually lengthening upwards, up to about 45 cm. long on robust culms, covered when young with fugaceously appressed-silvery hairs. Culm-sheaths thick, covered with scanty golden-yellow hairs outside, polished inside, about 38 cm. long and 30 cm. broad at the base, top rounded towards the short (about 10 cm.) and narrow blade.

Leaves ovate-lanceolate, 33—38 cm. long, 4.5-8.5 cm. broad, rounded at the base,



Sinocalamus copelandi (Gamble) Raizada.

A. A flowering branch. B. A. leafy branch. C. A spikelet. D. Lower bract. E. Upper bract. F. Lower glume. G. Upper glume. H. Lemma of the first (lowest) floret. I. Palea with stamens, ovary and style of the lowest floret. J. Three lodicules of the lowest floret. K. Two caryopses.

almost smooth and glabrous above, very softly, hairy and scabrous beneath; secondary nerves quite prominent, transverse veinlets visible on the lower surface; leaf-sheaths striate, long white-ciliate at the edges, ending in a small callus below the petiole and truncate at the mouth.

Inflorescence a large compound panicle of long, whip-like curved spikes; spikelets clustered in heads of 2—10 with 2 small bracts at the base (bracts broadly ovate, ciliate on the margin); rachis between the heads 1 cm.—4.5 cm., glaucous or somewhat puberulous; spikelets 2.5—3.8 cm. long, 5—7 mm. broad, ovate, acute, faintly pubescent, slightly compressed, with 4—7 florets, tinged purple outside, top most floret sterile.

Lower glume broadly ovate, acute, about 12-nerved and with conspicuous transverse veinlets, ciliate on the edges, about 7 mm. long, pubescent and purple tinted.

Upper glume very similar to the lower in shape, texture and pubescence, 12 mm. long, 22-nerved with anastamosing strands.

1*st lowest floret;* lemma broadly ovate, 12 mm. long, pubescent outside, ciliate on the edges, margins convolute clasping the rhachilla at the base, longitudinal nerves about 24, transverse veins obscure. Palea 13 mm. long, almost membranous, prominently keeled, ciliate on the keels and margins deeply cleft at the apex, 3-5-nerved.

Stamens six, exserted; anthers 8 mm. long, sagittate at the base, apiculate, pale-yellow. Filaments free, about 15 mm. long, thread-like.

Ovary turbinate, 6 mm. long, densely hairy at the top; style long (up to 15 mm.) sparsely hairy all over, ending in a simple plumose stigma, exserted at the apex.

Lodicules 3, lanceolate, hyaline, hairy on the margins.

The 2nd, 3rd, 4th, 5th and 6th florets are similar to the 1st lowest floret except that the lemma and palea get progressively longer from below upwards.

The 7th floret is sterile without any trace of palea, stamens or ovary.

Caryopsis 12-16 mm. long, contracted towards the apex, almost bottle-shaped, slightly grooved on one side; pericarp rather thick and loose.

Discussion

Through the courtesy of Dr. E. D. Merrill of the Arnold Arboretum my specimens and description were kindly scrutinized by Prof. F.A. McClure, formerly of the Lingnan University, Canton, China, and at present working at the Smithsonian Institution, United States Natural Museum, Washington. He suggests that the inflorescence and spikelet characters of my specimens are very similar in many respects to those of *Bambusa oldhami* Munro from Formosa, to which species in his opinion this bamboo is closely related. The fruits of *B. copelandi* appear to him to be intermediate between that of *Dendrocalamus* and that of *Bambusa*, sharing some characters of each. He further adds: "I do not find any thing in the specimens from Dehra Dun collected by M. B. Raizada that suggests the genus *Thyrsostachys*, the spikelets of the type species of which at least, terminate in a prolonged rhachilla segment tipped with a tiny rudiment, as in *Schizostachyum*, except that in *Thyrsostachys* this terminal structure is not engulfed by a dorsally sulcate or fistulose palea."

The genus *Sinocalamus* was set up by McClure in *Lingnan University, Sci. Bull.* 9: 66-6 (1940), to include several Chinese bamboo which were apparently intermediate between *Dendrocalamus* and *Bambusa*. In this he has placed *Bambusa oldhami* Munro, *B. beecheyana* Munro, and *Dendrocalamus latiflorus* Munro.

McClure's genus *Sinocalamus* though very closely related to *Dendrocalamus* and *Bambusa* can easily be separated from both. From *Bambusa* it is distinguished by (*i*) having culm-sheaths with (*a*) comparatively very small blades, reflexed to varying degrees, rarely perfectly erect, (*b*) auricles very small, inconspicuous, naked or vary feebly fringed with sparse ore-setae; (*ii*) culms and branches thornless; (*iii*) leaves mostly large, round-based, with transverse veinlets (or pellucid glands) visible on the lower surface; (*iv*) spikelets ovate, compressed and compact, thus the very shortly articulated rhachilla rarely visible from the outside of the spikelets; (*v*) spikelets usually arranged in clusters at the nodes of flowering branches and branchlets, seldom solitary; (*vi*) branches and branchlets generally coarse, basal nodes of the branchlets much swollen, main branches sometimes very large often shortly rooted at base. It is easily differentiated from *Dendrocalamus* by (*i*)

conspicuous lodicules, mostly 3 in number; (*ii*) spikelets in clusters of several only at each node of the flowering branchlets, not in round congested dense heads of numerous spikelets as in *Dendrocalamus strictus* Nees and related species in the same genus; (*iii*) each spikelet bearing from 6-8 or more, seldom less than 5 florets.

On the basis of the known characters of *Bambusa copelandi* given above, I should say that it be transferred to the genus *Sinocalamus*. I, therefore, make the following new combination :

Sinocalamus copelandi (Gamble) Raizada com. nov.

I am, however, not at all sure that McClure's genus *Sinocalamus* as it is known to-day will remain sharply set off from either *Dendrocalamus* or *Bambusa* when more of the bamboos of South-east Asia are studied in the field.

NATURAL REGENERATION OF ANOGEISSUS LATIFOLIA

BY THE DEPUTY CONSERVATOR OF FORESTS, GWALIOR

(S/21/I.S.— Fertile seeds of "Anogeissus latifolia" are produced in abundance in years of deficient rainfall or the years following. This has been illustrated by the observations of the author in Sheopuri, Guna and other districts of Gwalior State).

One of the important peculiarities of this genus is the infertility of the seed. In spite of this, natural reproduction often appears in great quantity resulting in gregariousness. It is advocated that fertile seed is produced in large quantities only in years of deficient rainfall or in the years following it.

We have extensive areas under this species specially in Sheopur, Guna and Shivpuri districts; and it is generally observed that even in areas covered by old mature and semi-matured crops advance growth of any size is conspicuously absent and when such an area is presented for annual felling under the working plan, the marking officer is baffled with the fate of the forests as artificial regeneration is not always possible. Had the species been producing fertile seeds even at intervals, such a condition would not have occurred. It is quite likely that there may be existing some other unfavourable factors in the present localities but when I happened to revisit some such areas of district Sheopur in last April, after about 5 years it was a very pleasing sight.

The ground is covered with innumerable young seedling crops from 2 ft. to 6 ft. in height under dead or dying or half dried-up mother trees and this substitution of young crop for the old has taken place during the last four years on a very large scale in this district. I was in charge of Sheopur district between years 1938 and 1942. The normal rainfall of the place is 33 inches but during my stay there the rainfall figures have been as follows:—

1938: 24·10.
1939: 20·75.
1940: 11·28.
1941: 16·25.
1942: 16·90.

With such continuous deficient rainfall this species exhibited pronounced unhealthiness and signs of dying back in 1941.

All other factors being the same now when the areas are covered with dense young crops of seedlings it cannot but be concluded that this reproduction is the result of production of fertile seeds after the year or years of drought.

The problem of regenerating *Dhou* forests which lack young crops could I think be solved with ease if large quantities of seeds are collected in years of drought or in one or two succeeding years and tried in areas deficient in natural reproduction.

THE PANCHAYAT FORESTS OF THE MADRAS PRESIDENCY AND THE FUEL PROBLEM

By K.N.R. Nair, B.A., B.SC. (Edin.).

(*Assistant Conservator of Forests Nellore*)

6/351/Md., 6/6301/Md.—An acute shortage of small timber and fuel was felt during the war which was popularly attributed to it. In fact the main sources of small timber and firewood were—"The Panchayat Forests." Large areas of minor scrub forests were handed over by Government in 1923 to Forest Panchayats which in the following 23 years by careless management and unchecked grazing and goat browsing have utterly degenerated. Ways and means to set matters right are suggested, comprising control of grazing, stoppage of goat browsing, planting linked up with the growing of food crops. The system of management being transferred to the supervision of the Forest Department, surprisingly good results are predicted in a decade).

In recent years an acute shortage of fuel and small house building timber has been felt all over the province, irrespective of whether they are towns or villages. The difficulty of getting transport facilities during the war period has made the problem all the more acute and along with the question of food, the popular government should tackle this question also and find a solution before it is too late.

A little careful thought would reveal that the war to which is attributed all our present miseries and hardships, had very little to do with our fuel problem. Indeed the dislocation and shortage of adequate transport facilities did affect the question of supplies to cities and big towns to a certain extent. But this by no means is the crux of the problem. To understand its magnitude, one has to study the sources from which the bulk of the supplies came both to the towns and villages. It can never be disputed that the main sources of firewood and small house building timber were the large areas of jungle covered land popularly known as *panchayat* forests. Improve and enrich the sources of supply and the problem will dissolve itself in a very short time.

The 'history' of the *panchayat* forests is both interesting and revealing. It was in the year 1923 that the government, as a measure of retrenchment, transferred very large areas of minor scrub forest (primarily intended for meeting the requirements of the villagers in the form of fuel, small timber and grazing) to the control of the forest *panchayats* and for the last twenty-three years, the forests have remained under their control. The intentions of the government were indeed very good. One of the main conditions of the agreement entered into between the government and the *panchayats*, was that the latter would carefully manage the forests and increase its capital value year by year. But unfortunately this remained only on paper and to-day one finds that with very few exceptions, the *panchayat* forests have been over-exploited and depleted of their forest growth that it is a misnomer to call them forests. Everything worthy of the name tree has been cut down and one may have to search hundreds of acres to find a tree of some eighteen inches girth and ten feet in height. On both sides of the railway line and the trunk road from Madras to Calcutta, could be seen vast areas of these forests covered by patches of scrub growth consisting mainly of low thorny bushes not above five or six feet in height, prickly pear and cactus. Any shrub growth above ten feet in height and eighteen inches in girth is a surprising feature in most of these areas.

What were the causes for this utter degeneration? The answer is simple. Long years of careless management coupled with unchecked grazing and goat browsing brought these areas to their present useless condition. It is a common sight for a railway passenger going from Madras to Bombay, Delhi, or Calcutta, to see large flocks of sheep and goats in the *panchayat* forests on both sides of the railway line nibbling at everything except probably the prickly pear, and thereby destroying the growth completely. There is another aspect of this problem which is equally, if not more, important with the question of fuel supplies and is one that should be tackled

immediately. It is erosion. The removal and destruction of the forest growth which formed a protective covering to the soil and an effective barrier against erosion, has exposed the soil to the hot sun and monsoon rains and the results have been disastrous everywhere. For a majority of the areas, the continuous exposure of the soil, to the hot sun has brought about the complete disappearance of all growth and the monsoon rains have cut up deep gullies, washing away all the fertile surface soil and exposing the subsoil which, in most cases, is hard laterite. The sand and gravel thus washed off are deposited in the adjacent fields thereby diminishing their fertility and value. Immediately after the recent unprecedented north-east monsoon, the writer has seen several fields covered with a layer of sand and gravel often four to five inches in thickness. In these days of acute food shortage, it can easily be imagined what this means to our 'Grow More Food' campaign.

Having thus realised the extent of the damage done and its implications on some of our vital problems and national economy, the next step is to devise ways and means to set matters right. The most important thing to be done is to check grazing and prevent goat browsing altogether. Forest officers all over India have been crying hoarse over this problem, but unfortunately the people as well as the authorities have not yet realised its importance. Rotational grazing and limiting the number of cattle that are to be allowed in any particular area are two of the essential pre-requisites of restoring the forests to the original condition. Side by side with this a well-planned and organised planting programme should be launched and the people encouraged to play their part by judicious propaganda. There are several indigenous species such as *Pitholocobium dulcies*, *Acacia arabica*, *Thespesia populnea*, *Melia azadiracht* (*neem*), *Cassia siemea*, *Acacia auriculiformis* and *Odina wodier* that could be grown more or less easily. *Thespesia populnea* and *Odina Wodier* are two useful species that could be grown by planting branch cuttings at the beginning of the monsoon and besides providing fodder and manure leaves, the former (*Thespesia*) gives an excellent timber that could be put to various uses. In addition to the above, wherever the conditions are suitable, *Casuarina* and *Eucalyptus*, which give very good fuel in a short period of eight to ten years, may be grown.

This planting programme may conveniently be linked up with the 'Grow More Food' campaign. In all areas where the soil conditions are suitable for the cultivation of dry crops, *kumri* cultivation, free of any assessment, should be encouraged and the *kumridar* made to look after and tend the trees till they have passed the stage of being damaged by cattle. In many parts the soil is so poor that cultivation of dry crops may not be profitable. In such areas the planting may be done under the immediate supervision of the *panchayat*. Strips, three to four feet in width, may be laid out at intervals of every half a chain and the seeds or twigs planted along the strips at an espacement of 10 or 12 feet. Provided this is done just at the beginning of the pre-monsoon showers, the plants will establish themselves by the end of the cold season and very little attention, except protection from grazing, will be required after that. Watering once or twice a week may have to be done in some parts during the months of May and June, but this is not so difficult as people imagine it to be and the amount spent in that way is more than repaid by the beneficial results obtained. It is essential that the areas taken up for such regeneration work should be closed to grazing for a period of at least three years and it is here that the active support and co-operation of the villagers are required.

Hitherto the forest *panchayats* were under the control of the revenue department and as that department, more than any of the others, was called upon to shoulder various responsibilities, particularly during the war period, the forest *panchayats* were more or less left to themselves with very unfortunate consequences. In future, it would be better to form the forest *panchayats* with the district forest officers of the respective districts as presidents and the collector as the *ex-officio* president. A regular and comprehensive scheme of planting may be drawn up under the direction of the district forest officer and the *panchayat* should be entrusted with the working of the scheme. The writer feels confident that with proper and adequate support and encouragement from the government, surprising results are sure to be obtained within a decade and the present acute shortage of fuel, timber and grazing will not be felt again. Let us hope that the popular government will look into the matter and act without delay.

USE OF ENUMERATION DATA AND YIELD TABLES TO CALCULATE THE C.A.I. OF A FOREST WITH A VIEW TO FIX ITS YIELD

By R. Sahai, I. F. S.

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(G/6361/U.P., S/3/U.P.—A method of calculating the yield, with the help of partial enumeration data for conversion forests is outlined and illustrated. The method is applicable to selection forests also).

This method of fixing the yield of a forest uses the principle that the maximum yield that can be removed from a forest without depleting the existing stock is its current annual increment. Enumeration data give the number of trees per acre of the various diameter classes while the yield table gives the volume of the mean tree and its current annual increment for the various diameter classes.

The following example of yield calculation for the *sal* conversion working circle in the Dehra Dun forest division will illustrate the principles. The area of this working circle is 68,500 acres.

The valuable forests of the Dehra Dun forest division contain mostly *sal* (*Shorea robusta*). *Sal* constitutes more than 90 per cent of the main crop and is of III quality.

The yield table (1943) for III quality *sal* gives the figures in column (1) to (4) of the following table:—

Crop age.	Average diameter.	No. of trees.	Standing volume stem timber.	Volume of mean trees.	C. A. I. of the mean tree.
1	2	3	4	5	6
65 ..	10.2	138	1,090	7.89	
100 ..	14.3	74	2,070	27.98	0.5736
145 ..	18.3	45	3,040	67.56	0.8796
150 ..	18.7	43	3,140	73.02	1.092

N.B.—The figure in column (5) is obtained by dividing the figure in column (4) by the corresponding figure in column (3). The figure in column (6) is obtained by dividing the difference between two successive figures in column (5) by the corresponding difference in column (1).

Taking only the fit *sal*, enumeration result gives the following distribution per acre:—

12 in.-16 in. III class.	16 in.-20 in. II class.	Over 20 in.- —I class	
		20 in.-24 in.	over 24 in.
10.02	5.131	2.018	
		1.474	0.548

The number of *sal* trees in the IV class *i.e.* 8 in.-12 in. diameter class was estimated by Smythies' formula on the assumption that during the felling cycle recruitment from IV class to III class is equal to the loss in III class due to passing into II class and mortality in III class.

$$\frac{f}{t_{\text{IV III}}}\,\text{IV}\left(1-z_{\text{IV}}\right) = \frac{\ }{t_{\text{III II}}}\,\text{III}\left(1-z_{\text{III}}\right) + \frac{f}{t_{\text{III II}}}\,\text{III}\,\frac{z}{\text{III}}$$

$$= \frac{f}{t_{\text{III II}}}\,\text{III}$$

where f is the felling cycle,

$t_{\text{IV III}}$ is the time taken for IV class trees to pass into III class

$\frac{t}{\text{III II}}$ is the time taken for III class trees to pass into II class

$\frac{z}{\text{IV}}$ is the percentage of IV class trees that die and do not pass into III class in $\frac{t}{\text{IV III}}$ years.

$\frac{z}{\text{III}}$ is the percentage of III class tre s that die and do not pa s into II class in $\frac{t}{\text{III II}}$ years.

IV is the present number of (8″—12″) diameter class trees.

III is the present number of (12″—16″) diameter class trees.

Value of t and z.—No data are available for t and z for irregular forests. Their calculated values according to the existing working plan procedure, but based on the new *sal* yield tables, are as follows:—

Quality class	Diameter class (inches).	Age	No. of trees per acre.	Total disappearance No. of trees.	z(per cent.)	t (years).
II/III ..	8—12	43	201	..	..	..
	12—16	71	117	84	42	28
	16—20	104	68	49	42	33
	20—24	144	43	25	37	40
III ..	8—12	48	193	..	..	..
	12—16	79	104	89	46	31
	16—20	118	59	45	43	39

As the values of t and z for II class (16″—20″) diameter trees are not available for III quality, the corresponding values for II/III quality class will be used. Applying these values of 't' and 'z' and III (from the enumeration result given in para 5) in the above formula, we get :

$$\frac{f}{28}\text{IV }(1\text{-}0.42) = \frac{f}{33} \times 10.02$$

$$\therefore \text{IV} = \frac{10.02 \times 28}{0.58 \times 33}$$

$$= 14.66.$$

The following table is obtained by using the figures in paras 4, 5 and 7:—

Diameter class (inches).	No. of trees per acre in the diameter class.	Average diameter of mean tree.	Volume of mean trees	C.A.I. of the the mean tree.	C.A.I. of the diameter class.
8—12 ..	14.66	10.2	7.89	0.5736	8.412
12—16 ..	10.02	14.3	27.98	0.8796	8.812
16—20 ..	5.131	18.3	67.56	1.092	5.603
Over 20 ..	2.022	..	..	..	..
Total ..	..	..	..	..	22.827

This shows that the C.A.I. per acre is 22.827 c. ft. and corresponds to 0.8156 trees of 12″—16″ class or 0.8156 *sal* units as defined below:—

Diameter class		*Sal units.*
Inches.		
8—12	..	.. ¼
12—16	..	.. 1
16—20	..	.. 2
20—24	..	.. 3
Over 24	..	.. 4

So, the C.A.I. for the whole working circle
$= 68{,}500 \times 0.8156$ units
$= 55{,}880$ units.

The actual C.A.I. will be slightly more than 55,880 units, as in the above calculation the C.A.I. of unfit trees and those of trees below 8″ diameter is not taken into account. This is the maximum annual yield that can be removed from the forest without depleting the existing stock. The actual yield may be more or less according as the stocking in the forest is above or below the normal.

The above method can be usefully applied to forests under a selection system where trees above a particular exploitable diameter are marked. Thus, if *sal* trees above 20 inches diameter are to be removed under a selection system the annual yield will be $\frac{55,880}{3}=18,627$ sound and fit *sal* trees over 20″ diameter.

This method is also eminently suitable for fixing the yield for irregular forests under a system of conversion to uniform with periodic blocks, as in the Dehra Dun forest division where a part of the shelterwood is being retained after P. B. I. fellings for protection against frost and/or to produce seed and a portion of the young crop is retained as part of the future crop to avoid unnecessary sacrifice. In such cases the yield is calculated for the whole working circle by the above method and is expressed in terms of *sal* units. This yield will be taken out of the various periodic blocks *viz.* main fellings in P. B. I., removal of standards in young P.Bs., removal of mature trees and thinnings in intermediate P.Bs. and thinning in old P. Bs. (other than P.B.I.).

DEBUNKING THE BUNK

By Eleanor Bor

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The Psalmist, extolling the omnipresence of his God, sang"—If I climb up into my bed Thou art there—even there also will Thy right hand lead me and Thy left hand follow me".

This may be so. All the same, one's bed—one's bunk, one's cot or crib, call it what you will—it is one's own most Personal Belonging. It is our most trusted friend. It shares our most intimate secrets. It is our final refuge from the fuel shortage.

In all the house no piece of furniture is so completely one's own as one's bed. Each of us may claim our special chair or appointed place at table. We may be lucky enough to call a dressing-table or a writing table our very own. But at times we yield these to the claims of a visitor. Not so one's bed. Unless conditions are hideously overcrowded. And of course there are those (surprisingly numerous) who still accept a double bed as part of life. But this is not written for patrons of the Double Bed. It is written for those who reverence the singleness, the solace and the solitude of bed.

Think of your own bed now. It's there, in your room, waiting for you to-night. The moment will come when you will fetch that ineffable sigh, kick off your irritations along with your slippers (if you've got any sense) and fall into the comforting embrace of Bed. How one longs for it at night (and at various times throughout the day), and how appalling it is to have to leave it in the morning.

And there—in the mornings—we meet with certain quaint traditions concerning the Making of Beds. For years many of us have been silently rebelling against these traditions. Few of us have had the courage to rebel openly. We have resorted to strategy and deception. Such an attitude is contemptible. The time has come to debunk the Bunk.

Let us face up to it. Time to Make the Beds. What a depressing phrase! What mournful visions of chilly bedrooms where blankets must be heaved, sheets dragged off, pillows punched and—final horror—the Mattress must be Turned.

This sinister custom, this superstition that Mattresses must be Turned, why do we submit to it? Before we left school most of us had acquired a pretty skill in evading the nuisance, but in later years backsliders revive the custom and frown on those who defy it. Strong men have been driven to locking their doors against intruders who might jeer at the way they deftly toss back the bedclothes without turning the mattress.

It is alleged that mattresses get hard and lumpy if not turned. Well, why not? Some of us like lumps. And, anyway, if you turn the mattress you only re-distribute the lumps. Having got used to a nice lump under one's shoulder, it is disquieting to find it nestling under one's knee.

And, in any case, when is one's bed most comfortable? Nearly everyone will agree that the most luxurious moments in bed are those stolen seconds just before you have to get up. Never through all the night has one's hollow been so exactly right, never so warm and soft;

never have the pillows rested so smoothly under one's head. And now—just when everything's perfect you've got to get up.

And not only get up. One is, at this moment, expected to perform an insulting rite known as Airing the Bed. This to be followed (after a decent interval) by Turning the Mattress and Making the Bed. Why? The bed is perfect as it is.

There it lies just as you have left it (unless you are one of those who spring up with a shout of morning joy) all warm and comfortable and inviting. Then why not try to preserve that state of comfort which it has taken the whole night to perfect? If one shows true respect for the bed, one emerges from it carefully, trying not to disturb in any way that condition of bliss which one knew on waking.

Having dragged yourself out with the utmost care, all you have to do then (with still greater care) is to drag the bedclothes up, treating them gently and reverently so that they will lie lightly over the hollow where you will rest to-night. A simple operation, all of which can be completed before breakfast—or even before you begin to dress.

That, you would think, is the sensible way to do things. But hoary—not to say mouldy—tradition says No.

No. You're supposed first to "strip" the bed, (what humiliation) and leave it "to air" till after breakfast. And then, when you're usually pressed for time, you're expected to behave like a galley slave—turning the mattress before untwisting and spreading the sheets, tossing the blankets and doing a kind of walking race round and round the bed, tucking in and smoothing down until you've made the bed only fit for a flat fish to sleep in. It is intolerable.

Another quaint custom concerns what is known as the "Day Cover"—an ornamental covering which we are expected to take off every night, fold up neatly (usually a very tricky job) and place on a chair or on top of the chest of drawers, whence it slides down on to the floor. This sort of ritual was all very well in the days when trim housemaids did the job for us. But to-day the custom should be declared obsolete.

Who wants to be peeling off and folding up "Day Covers" when you and your bed are yawning for each other? Day Covers must go. Or be allowed to stay put, at night.

Finally we come to the question of Clean Sheets. There was a picture in "Punch" during the 1914 war. It showed the typical country house bedroom. Everything of the best. In the middle of the room stood a shivering officer home on forty-eight hours leave from the trenches. Shuddering away from the fumed oak bedstead he was saying:—"Fancy having to take off all one's clothes and get in between clean sheets! Ugh!"

How many of us know that recoil from the chill welcome of clean sheets? How many of us think of our nice crumpled sheets worn to a caressing softness, while we wish that the laundry would delay things a bit longer?

Clean sheets, now and again, are necessary. But why so often? We are content to use the same blankets for months. Why clean sheets? After all, it's one's own bed; if the sheets are dirty it's one's own dirt.

But here a chorus of boos and hisses makes itself heard, the subject must not be pursued.

Rather, let us turn once again and contemplate the bed.

It stands there with its Top Covering (not a Day Cover) neatly drawn up. It is advisable to have these Top Covers fashioned from some thick, squashy, uncreasable stuff. To look at the bed no one would guess at the comfortable confusion that obtains underneath the top cover.

You did not Air your Bed this morning; you did not not Turn the Mattress; a purist would say that you had not even made your bed. You simply pulled the things up, shoved the pillows down and patted the top cover till it hid the bumps underneath.

And if to-night you can't find your pyjamas or the book you were reading before you turned off the light—well there you are, you've made your bed, no doubt you'll enjoy lying in it. If you find the top sheet twisted into a rope that tries to throttle you. If the pillows rise up and try to suffocate you. If the blankets slip sideways and leave you a prey to the dangers of exposure, exactly the same thing would have happened if anyone else had made the bed.

At least you will have done what you could to debunk the superstitions that hang like cobwebs around the business of Making one's Bed.

EFFECT OF AGE AND SEASON OF FELLING ON THE STRENGTH PROPERTIES OF BAMBOO

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(6/1146/R.I., S/3/R.I.—As a result of an investigation made by felling young and mature bamboos in cold as well as the hot season, the tentative conclusion is drawn that the cold season fellings generally produce stiffer and stronger bamboos than those felled in the hot season, mature bamboos being 40 to 50% stronger and stiffer than young ones in either season).

Clear felling of entire bamboo clumps was often practised during the war-time in order to supply the heavy demand for bamboos. Young and mature bamboos thus got mixed up and questions were often asked about differences in their strength properties. It was, therefore, decided in March 1945 in consultation with the Silviculturist and the Entomologist at the Forest Research Institute to do comparative strength tests on young and mature bamboos felled at different seasons in order to find whether the age and the season of felling affected their strength properties.

Material for testing

Bamboos of the *Dendrocalamus strictus* species were obtained for testing from the Forest Research Institute demonstration area. One young and one mature culm from each of 50 clumps were felled in May 1945, *i.e.*, in the hot season. A similar number was also felled in December 1945, *i.e.*, the cold season. Young here means culms 9 to 12 months old and mature means about 2 years old.

Tests

On receipt at the laboratory, the young and mature culms, were matched with each other as far as possible taking into consideration the outside diameters and the thickness of walls and converted into matched specimens for testing in the green and seasoned conditions. Three specimens were obtained from each of the fifty culms, *viz.* one from the bottom end, and one from the middle and one from the top end, thus making up altogether 150 specimens for testing for every batch. Half of these were tested green and half after kiln drying. Each batch of tests is, therefore, made up of 75 specimens, but the actual number of tests is somewhat less as shown in Table 2 owing to rejection of bad material.

Static bending and compression parallel to grain tests were done. Altogether about a thousand tests were made.

Results of tests

The tests in the green condition have been finished and computations also done. The tests in the seasoned condition have also been finished but the computations are still pending. Table No. 1 gives only the results of tests in the green condition. A final report will be submitted when results of seasoned material are available.

Table 1

Average results of tests on *Dendrocalamus strictus* (bamboo) felled in May 1945 and December 1945 from demonstration area, New Forest, Dehra Dun :

Time of felling.	Growth.	Modulus of rupture lbs. per sq. inch.	Modulus of elasticity 1000 lbs. per sq. inch.	Max. crushing stress lbs. per sq. inch.
May 1945 ..	Mature	10,500	1,830	5,150
	Young	79,000	1,340	3,650
December 1945 ..	Mature	13,600	2,220	6,000
	Young	7,600	1,600	3,400

Statistical Analysis of Test Results

Table 2 gives the statistical analysis of average test results given in Table 1. It will be seen that December fellings have given significantly higher results than May fellings in all the three strength functions in the case of mature bamboo. In the case of young bamboos only the modulus of elasticity of December fellings is seen to be significantly higher than May fellings. The other two strength functions for young bamboos do not show much difference.

Mature bamboos have in all cases given very significantly higher results than young bamboos. This is evident even without any statistical analysis. However, the last two lines in the Table give an analysis for modulus of rupture of mature and young bamboos which shows the difference as highly significant.

Table 2

Statistical analysis of the strength of mature and young bamboos (green) felled in May (hot season) and December (cold season):

Condition of growth.	Strength function.	Time of felling.	No. of tests.	Mean strength.	Standared deviation.	Significance of difference of means.
Mature.	Modulus of Rupture.	May.	60	10,500	2,060	Highly significant.
		December.	66	13,600	2,560	
	Modulus of Elasticity.	May.	56	1,830	500	Do.
		December.	65	2,220	600	
	Maximum crushing strength.	May.	60	5,150	755	Do.
		December.	62	6,000	1,045	
Young.	Modulus of Rupture.	May.	54	7,900	1,890	Not significant.
		December.	65	7,600	1,775	
	Modulus of Elasticity.	May	46	1,340	445	Highly significant.
		December.	51	1,600	500	
	Maximum crushing strength.	May	54	3,650	595	Significant.
		December.	63	3,400	685	
Mature.	Modulus of Rupture.	December.	66	13,600	2,560	Highly significant.
Young.	Modulus of Rupture.	December.	65	7,600	1,775	

Figures for modulus of rupture and maximum crushing strength are in lbs./in. and those for modulus of elasticity are 1,000 lbs./sq. in.

Tentative Conclusions

1. December felling, *i.e.*, felling done in the cold season is generally seen to produce stronger and stiffer bamboos than those felled in May, *i.e.*, the hot season.

2. Mature bamboos felled in either the hot or cold season are seen to be roughly 40 to 50% (or even more) stronger and stiffer than similar young bamboos.

PRUNING IN PLANTATIONS

By Jagdamba Prasad, Silviculturist, F. R. I., Dehra Dun

(C/137/R.I.—Forest pruning is defined and the method of knot formation is outlined. The object of pruning is explained and the best age for pruning indicated. The peculiarities of the species must be taken into account in pruning specially as regards susceptibility to fungoid attack, exuberance of lateral branches persistence of dead branches, season of pruning, selection of stems for pruning and methods of pruning are then discussed, with notes on subsequent treatment and costs. A review of American and Indian experiments is given at the close).

Introduction

The operation of forest pruning consists in the removal of the lower dead or live branches, which, if allowed to remain, form knots in the timber of the main stem. The chief object of pruning is to obtain timber as free from knots as possible.

Definition of a knot.—A knot is a position of a branch which has become occluded and enclosed in the wood of the tree stem. It is thus a portion of a branch or limb that has become incorporated in the body of a tree.

Method of knot formation.—When a branch dies its base is still nourished for several years afterwards and a callus is formed around it. The longer a dead branch remains fixed to the tree, the longer is the portion that becomes occluded by tissue. When the branch falls off or gets broken, the stub gradually becomes completely covered by the growing wood around it and is eventually embedded in the stem of the tree. The basal portion of the branch is definitely connected to the wood around it, but the remainder is usually unconnected with the surrounding wood which grows over and around it and without connection with it. If a plank is later cut through the basal portion, the knot is still part of the wood and does not become loose when the wood starts to dry out. This type of knot is known as a live or tight knot. It is also spoken of as an intergrown knot, because in it the rings of annual growth are completely intergrown with those of the surrounding wood.

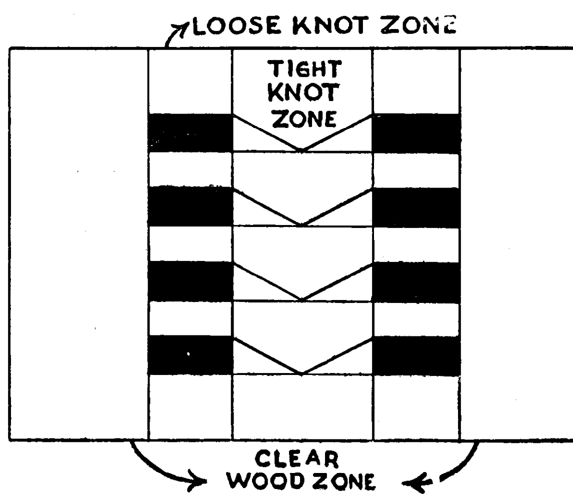
If the cut is made through that portion of the original branch which has no fibrous connection with the stemwood, the resultant knot will become loose, when the surrounding wood shrinks on drying and will eventually fall out. This type of knot is known as a deap or lose knot, or an encased knot.

Dead knots.—Natural pruning in forest trees comprises the process of the gradual dying of lower branches and finally the separation or disappearance of any protruding portion. A dead branch or branch stub may persist for many years and become after dying the source of even greater degrade of timber than when alive. Dead branches cause loose, black or decayed knots. Dead branches should therefore be pruned as soon as possible to minimise the formation of black knots.

Live knots.—Knots from living branches are firmly intergrown and usually less conspicuous in colour than dead knots. These live or tight knots may actually enhance the value of some classes of wood by improving its appearance. A good example of this is the birds-eye maple (*Acer* spp.). Pollarded oak trees often give the same type of wood. Other examples are *Dalbergia sissoo* and Central Indian teak.

I. Zonal division of steem timber apropos of knots

A mature tree contains 3 distinct zones with respect to knots which affect the grades of timber that may be cut from it.



The inner zone or cone, called *the tight-knot* zone, consists of the portion of the tree trunk which grew before the contiguous lateral branches died. The second zone consists of the portion of the trees containing encased or loose knots. This zone may be variable in radial thickness, depending upon the rate at which natural pruning has been accomplished. It is situated between the tight-knot zone and the clear-wood zone, provided a clear-wood zone has been formed. The loose-knot zone extends to the bark in that portion of the trunk lying between the upper limit of the clear-wood zone and the base of the green crown. The clear-wood zone is the most valuable part of the tree for timber, veneer and many other uses, although not so important for pulpwood posts, poles and fuel. Young trees which have only a relatively thin clear-wood zone have just reached a point where their growth is becoming most profitable and should not be cut until the clear zone is thick enough for advantageous use. In some species the age at which clear-wood begins to be formed can be greatly shortened by artificial pruning of the tree trunk. Pruning is done in young stands and therefore in stages, but longer and longer intergrown and dead knots result if the interval is not shorter *i.e.*, beyond 4 or 5 years at most.

II. Object of pruning

Generally speaking, as we have seen above, knots are a serious defect in timber, especially in conifers. For example, the presence of bad knots in railway sleepers, particularly in the portion where the spikes holding the rails are driven in, is sufficient to disqualify a sleeper for railway use. In the northern group specification for conifer sleepers only one knot one inch in diameter is allowed near the rail seat and the largest tight-knot allowed in the rest of the sleeper must not exceed three inches in diameter. Whenever knottiness causes serious reduction in the grade and price of timber or in the total rejection of timber for a specific use, the question of the advisability of pruning is worth investigation. Timber that is grown for special purposes such as veneering and turnery may have to be absolutely free of knots. Thus although the only justification for pruning on a commercial scale is the resulting increase in timber value, the pruning of forest trees may also be undertaken to meet special local conditions as in the removal of the lower dead branches from all trees as a fire-protection *measure or to improve working* conditions in the stand, or the production of clear wood may be secondary to such immediate objects as the release of advance growth, improvement of tree form, correcting malformations in young trees, minimising snow damage, and restoration of balance between root and leaf actually following a period of adverse conditions.

III. Best age for pruning

Pruning must be done (INDIA) as early in the life of the trees as possible as the branches are then small, pruning is cheaper, healing quicker and the diameter of the knotty core smaller.

The earlier the trees can be pruned (GREAT BRITAIN) the smaller will be the central core of knotty timber and the wider the zone of clean wood put on after the pruning wounds have closed over. Pruning should start, if possible, at or before the first thinning, or when the trees average not more than 4 inches in diameter at breast height. With rare exceptions (*e.g.* Douglas fir on very favourable sites) it will not pay to prune plantations in which the average diameter of the dominant trees exceeds 7 inches.

Scots and Corsican pine (GREAT BRITAIN) are brushed up from 13 to 15 years old, and spruces and Douglas fir, 9 to 12 years old, according to the situation and growth of plantation. High pruning has been done on Douglas fir and Sitka spruce at 15 to 16 years old.

The best time to begin pruning western white pine (AMERICA) is when the average measurements of the stand are 5 inches in d. b. h. and 30 ft. high when pruning can be taken up to $7\frac{1}{2}$ ft. MEYER (AMERICA) found that 3 to 6 inches d. b. h. was the best size for pruning white and red pine. However (AMERICA) for fast-growing species that are being managed on a short rotation for the production of clear lumber, the sooner the dead branches are removed the better.

The best time to commence brushing up is when the trees are no more than 4 to 6 inches in diameter (GREAT BRITAIN) so that the core of the knots will be as small as possible.

From the above it is clear that pruning must be done early, but of course the actual time for each species will have to be worked out from experiments keeping in view the special requirements of the final product.

IV. Species

In all forest pruning operations the first point to consider is the peculiarity of the species concerned and the manner of its response to the operation. The instances given below indicate some of the problems that are likely to be met.

(a) Susceptibility to fungoid attack

There are numerous records from Germany and other countries of Europe of disease resulting from the live pruning of Norway spruce. The pruning of Norway spruce should, therefore, until investigation proves otherwise in future, be confined to the removal of dead branches. The same rule should for safety be observed with Sitka spruce. Douglas fir, Scots pine and European larch are believed to take no hurt from live pruning. Corsican pine can probably be included in the same category of the broadleaved species, oak responds well to live pruning as long as the branches are small (not more than one to two inches in diameter). The largest oak branches considered permissible for pruning are 3 inches diameter in slow-growing and 4 inches diameter in fast-growing trees. Beech requires special treatment as the pruning of live branches flush with the stem is considered by continental authorities to be very hazardous for it usually results in decay spreading into the main stem. Where pruning is unavoidable shorten the side branch to a stump of about 2′ in length. This should be cleanly removed in about 5 years, after it is completely dead. Sometimes the stump of a branch will produce leaves and in that case it must be further shortened. Ash and Sycamore are both regarded in Germany as species which are better left unpruned.

(b) Exuberance of lateral branches

The plane tree (*Platanus orientalis*) in youth naturally develops an exuberance of primary lateral branches on its stem and there is a contest for leadership amongst them at the top. No one of these branches continues its growth by a terminal bud—a feature of other trees also—lime, elm (*Ulmus wallichiana*), for instance. Arrest and self-pruning of the tip takes place, and the elongation of the shoots proceeds from lateral buds nearer to, or farther from, the primary tip. The continuation bud may be the one immediately behind the point of abscission of the shoot tip, but often the shoot dies back to some distance behind the normal abscission line of self-pruning, and thus the elongation of a shoot in any one season is no measure of the permanent addition in length that is to be made to the axis, whether terminal or lateral of which it is a part, for only the base of the annual growth may survive. If the tree grows freely without natural or artificial curtailment and discipline, a relatively heavy brushhead is formed of intricate zig-zag branches of which the termination may be dead.

(c) Persistence of dead branches

In Europe for species like spruce or Douglas fir which may retain their dead side branches for 70 years or more, pruning is essential for the production of clear lumber. Larch, Silver fir and Scots pine in increasing order of rapidity of natural pruning, are also considered to be worth pruning, though under some conditions pine may be left unpruned. Broadleaved trees generally clean themselves more readily than conifers, oak being slower than beech. In some cases oak is considered to be worth pruning, but beech never.

(d) Low forking

In Bengal, low forking species such as *Cedrela toona*, *Terminalia myriocarpa* and *Chickrassia tabularis* have been suggested as suitable subjects for pruning and it was also suggested for *sal*, but later experiments showed that *Sal* should not be pruned. Blanford (BURMA) recommended pruning in teak plantation, with particular reference to low forks and Robinson (MADRAS) for teak in Godavari district. Mulberry has to be pruned in the Punjab to get the clean stems necessary for the sports goods trade, side branches being removed when as small as possible, and not allowed to exceed thumb thickness. Timber of *Pinus longifolia* would be greatly improved by early pruning. An extreme example of persistent branchiness in which pruning would be essential to get clean timber is *Tsuga brunoniana* in Bengal.

(e) Economy

The fast-growing conifers with persistent branches, (GREAT BRITAIN) such as Douglas

fir, Sitka spruce, Norway spruce and Corsican pine are likely to give the highest economic return for pruning. Plantations of Scots pine growing on first or second site-quality classes are also considered to be worth pruning because of the high price obtainable for clean timber, and the special market for telegraph poles.

Pure plantations of the broadleaved species, (GREAT BRITAIN) oak, ash, beech, Sycamore should seldom require much in the way of pruning provided that the canopy is kept sufficiently dense in the early stages of growth. Pruning may, however, be necessary where broadleaved trees are grown in mixture.

Whether pruning will assist in obtaining desirable improvement such as an increase in height growth is a debatable point that needs to be settled by experiments. The following are two conflicting reports in respect of teak.

To ensure better height growth instead of thinnings pruning of teak coppice shoots in 4 years old coupes was carried out in the late winter of 1927 in Kumbraj range, Gwalior State, India. After 3 years it was noticed that the coppice shoots that had been pruned had put in very good heights and girth increment. The coupe when sold fetched at least 3 times the price for similar areas.

In the case of teak, again in an experiment with randomised blocks conducted in Madras it was found that pruning did not produce any increase in height growth.

(f) Knotty woods

From the timber user's point of view advice as to the species that need improvement is readily available. Indian examples of very knotty woods are *Pinus longifolia*, *Cedrus deodara* and *Taxus baccata*. Examples of species which are usually fairly free of knots are *Dalbergia latifolia*, *Dipterocarpus* spp. and *Calophyllum* species.

V. Season for pruning

There is a conflict of opinion as to the best season for pruning, but there is a consensus of opinion that it should be done when the trees are dormant or before the commencement of active growth. Thus :—

(i) It is considered safest to prune trees (GREAT BRITAIN) while they are dormant, but no objections are raised to pruning dead branches at any season.

(ii) Pruning should not take place (GERMANY) during the growing season.

(iii) Although some doubt exists on this question of the season of pruning (GREAT BRITAIN), the balance of evidence is against pruning during the late spring and summer months, when the sap is up. The best period is believed to be from the beginning of January to the middle of March, but the three months October to December are also permissible.

(iv) Most rapid healing is obtained if pruning is done in the late winter or early spring (February-March in England) shortly before active growth commences. Species may, however, vary as regards the best pruning season. Generally pruning should never be done during periods of active growth on account of the likelihood of the bark "slipping" and the cambium separating from the stem at the edges of the wound.

There are opposite views held as to whether spring is the season for pruning. One authority says that for pruning the spring months should be preferred (GREAT BRITAIN) to winter ones, as the healing over is so much more rapid. While another considers that although it does not appear (AUSTRALIA) that any season is badly unsuited, spring appears to be the the least favourable time. In spring the sap runs rather badly, the bark is easily stripped or injured, and the rapidly extending leading shoot may sometimes be broken by jarring or shaking of the trunk. Fungal infection has not been observed at any season, irrespective of the green or dead nature of the branches. Winter is probably the most favourable season for pruning, but it is also a very useful operation on which to employ extra hands during the fire season. This question again has to be solved, if done correctly at all for each species. Here are some experimental details for one. Green branches of Douglas fir (GREAT BRITAIN) were pruned close to the trunk (removing the collar at the base) in each month during 1936. Branches $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter pruned in February were entirely healed over before autumn, and those pruned in March, April and May were almost healed over.

Branches pruned in January healed more slowly, and those pruned after May healed

little or not at all during the same year. With Sitka spruce May pruning gave the best results.

VI. Selection of stems

The selection of trees to be pruned depends (GREAT BRITAIN) upon the object, the age, the species and the type of trees in the stand.

We should aim at prunning only those trees (GREAT BRITAIN) which it is thought will form the final crop.

Usually (a) weakly, suppressed, or sub-dominant trees, likely to come out in the next few thinnings and (b) crooked or forked stems which will not produce high grade timber or make useful poles should not be pruned (GREAT BRITAIN). It is common practice (GREAT BRITAIN), in order to reduce the cost of pruning, to select from 200 to 250 per acre of the best stems, evenly distributed over the ground for pruning. If a proportion only of the trees in a stand is pruned it is essential to mark the pruned trees to prevent confusion arising in the future by a ring of white paint or two dots on opposite sides of the stems.

But it is essential that the unpruned trees should not be allowed to stand longer than can be helped as investigations on *Pinus radiata* (AUSTRALIA) showed that the effect of green pruning on diameter growth was more marked when pruning was confined to selected trees surrounded by unpruned trees than when the whole stand was pruned and all trees were almost equally efficient in utilizing the site. The length of time during which increment is reduced as a result of green pruning may be considerably lengthened, if selected pruned trees are surrounded by large unpruned trees that are not fit for treatment.

VII. Method of pruning

1. *Tools.*

The hand saw and pole saw have been given (AMERICA) the most general approval, although individual preferences are shown for edge tools and shears.

The equipment found most suitable for pruning (GREAT BRITAIN) to a height of 15 to 18 feet in young plantations consists of the heavy hacker and mace for brashing (breaking dead branches from the lower portion of the tree) hand-saw (straight bladed, six teeth to the inch), Swedish pruning knife and stout bladed curved pruning saw (four or six teeth to the inch), on an extension pole. For pruning older plantations a 25-foot extension ladder, safety belt and climbing irons are needed in addition.

The second pruning will necessitate (GREAT BRITAIN) either the use of a ladder and hand saws or the work can be done from the ground using pole-saws. It is frequently as cheap to prune with hand-saws as it is with pole-saws, and the work can be done more cleanly.

2. *Method of cutting.*

The importance of clean pruning (GREAT BRITAIN) can scarcely be emphasised. Factors which make for good pruning are:—

(i) Sharpness of the saw or other cutting tool.

(ii) The angle at which the blade is held. The blade should be parallel to the axis of the stem and at right angles to the branch.

(iii) Position of cut. This should be as close to the stem of the tree as is possible.

3. *Length of clean stem.*

The height of pruning (GREAT BRITAIN) depends upon the object. For timber production up to 30 feet, for the longer poles up to 40 or 50 feet if locally grown poles come into greater use.

As the cost of pruning rises very rapidly (GREAT BRITAIN) with increasing height above ground there is a limit, beyond which it is uneconomic to prune. This limit depends upon a number of factors such as the future market for poles or timber of given lengths, the length of the rotations and the quality of the labour supply available. In general the economic height of pruning is considered to be between a minimum of 13 feet and a maximum of 30 feet with 18 to 24 feet as an average for most conditions. The longer pruning is delayed, the less the height, to which it will be economic to prune.

4. *Stages.*

Pruning, more or less, is divided (GREAT BRITAIN) into three stages:—

(1) Brashing up head-high (6 feet).

(2) From 6 feet to 18-20 feet.

(3) 18-20 feet upwards.

Pruning must be carried out in stages (GREAT BRITAIN), for to remove branches to the desired height in one operation may not be possible and may endanger the vitality of the

tree. The first operation is a brashing or removal of the lower branches up to about 5 or 6 feet from ground level or to as far as the workmen can reach *i.e.* to 8 or 9 feet, provided branch suppression has proceeded far enough to justify pruning to that height. The cost of this initial pruning can be considerably reduced by leaving unbrashed the smaller trees and those with defective stems.

HAWLEY & CLAPP (AMERICA) suggest a schedule of three pruning operations at 0-7 ft., 7-12 ft. and 12-17 ft. up the stem, each operation removing only those living branches not in direct sunlight and going up to but not including the highest interlacing branches of adjoining crowns. In plantations that have not closed but are ready for pruning, it is suggested that the branches in the lower 1/5 to 1/4 of the length of the living crown can be safely removed.

5. *Live pruning.*

At one period (GREAT BRITAIN) care was taken to cut off only dead branches, but now green branches not in direct sunlight are also cut off. Little or no bleeding takes place, and occlusion is definitely quicker. The branch should be cut off quite close to the stem even to the extent of slightly damaging the cambium.

Unless the "collar" of old bark on the branch is removed, valuable time is lost in the healing-over process.

It is necessary (GREAT BRITAIN) not to check the growth of the tree by removing branches which are actively functioning, and for this reason live pruning should be confined to those branches which are at least partially over shaded.

In 1935 experiments were carried out (GREAT BRITAIN) to ascertain the feasability of pruning green branches exposed to full light. Trees were pruned each month during 1935. Where branches of $\frac{1}{2}$ inch diameter or less were pruned, occlusion was complete (for the months of February, March, April and May) before the end of the growing season. Partial occlusion took place in all the other months' pruning.

Hawley and Clapp (AMERICA) favour the pruning of small branches while still alive as a means of minimising insect and fungus damage and of producing a better grade of timber. They report that in a 6 × 6 ft. white pine plantation the stubs less than $\frac{1}{2}$ inch in diameter cut close to the trunk will heal over completely within 10 years, whereas larger stubs take longer. Two other points (AUSTRALIA and GREAT BRITAIN) which relate to the speed of occlusion of pruning wounds, favour green pruning.

(a) That pruning should take place while the tree is putting on wide growth rings, and

(b) that the growth rings of the stem tend to turn outward to meet the live branch tissue, while they dip inward in the immediate vicinity of a dead branch stub.

VIII. Subsequent treatment

The rate of occlusion (GREAT BRITAIN) of branch scars depends largely upon the rate of diameter growth. When pruning is completed more room should be given to the selected trees to encourage the development of a large crown and consequently rapid diameter growth. The method of crown thinning, which has the object of freeing the well-shaped dominants while retaining sub-dominant and partially suppressed trees for soil cover, appears particularly applicable to pruned stands.

IX. Costs and economic aspect

Based upon the experimental work in the forest of Dean (GREAT BRITAIN), the following table of costs of pruning at different ages and to different heights is presented for four of the species named.

Estimated cost per acre (in shillings) of pruning.

Height of pruning, feet.	Douglasfir.	Scotch pine.	Norway spruce.	European larch.
1. Young plantations	(15-20 years)	350 trees pruned	per acre.	
10—12	35	20	23	6?
2. Young plantations	25-35 years.	240 trees pruned	per acre.	
12	24	16	16	4?
18	40	22	34	4?
24	60	38	45?	6
30	90	66	?	?
35	120	?	?	?

With the exception of Scotch pine an extra price of well under 1 d. per cubic foot on the final crop will repay the cost of pruning based upon an average pruning cost of 3 d. per tree. In the case of Scotch pine an increased cost would have to be from 1½ d. to 2 d. per cubic foot. It is suggested however, that in trimming out and peeling telegraph poles an appreciable proportion of the cost of pruning is likely to be recovered in the lower cost of preparing the poles from pruned trees.

The following are some Indian figures of cost of pruning.

Nature of operation	Cost per acre.	Locality.
	Rs. a. p.	
Pruning *Shorea robusta* to a height of 18 ft. from the ground to bark level	8 5 4	Buxa division Bengal. E. P. 25/1 & 26/1.
do. (of selected trees) ..	5 2 0	do. E. P. 25/2 & 26/2.
do. to cambium layer ..	11 3 5	
do. (of selected trees only) ..	8 1 5	
Pruning consisting of the ramoval of forks, double leaders and strong side branches for a spacing of 8½ ft. × 8½ ft. in May 1941 ..	8 0 0	Angul, Orissa.

The following table (GREAT BRITAIN) shows the increased price per cubic foot which would have to be obtained for the whole of the final crop, assuming that the trees were pruned to a height of 20 to 25 feet at a cost of four pence per tree. The accumulated costs per cubic foot have been calculated using a rate of 3½ per cent compound interest. The data for the average volumes of the trunks at the end of the given periods are taken from the yield tables issued by the Forestry Commission.

Species.	Quality class.	Age when pruned. Years.	Age at exploitation Years.	Accumulated cost of pruning per tree. d.	Average final volume per tree. Cubic foot.	Increased cost per cubic foot. d.
Scots pine. ..	I	30	85	25.3	28.1	0.90
	II	35	90	25.3	24.2	1.05
Norway spruce	II	25	70	18.8	38.3	0.49
	III	30	70	15.8	26.7	0.59
Douglas fir	II	20	50	11.2	41.3	0.27
	III	20	50	11.2	32.8	0.34

The time taken to prune to full height (AUSTRALIA) works out at 10 minutes per tree in the Australian capital territory. The total pruning cost coming to around £4 per acre, which amounts to about £11 6 s. per acre when compounded at 3½% for 30 years, which is considered a reasonable average time over which to compound charges for a 40-year rotation. This £11 6s. must be distributed over the 20,000 super feet of clear timber when it comes to about 1 s. per 100 super feet.

X. Experiments

(a) *America.*—A plantation of short leaf pine (*Pinus echinata* established with stock planted in the spring of 1935 on an old field in Southern Illinois (AMERICA) was used for the pruning experiment. On trees selected at random for pruning in April 1939, all branches up to half total tree height were trimmed off flush with pruning shears. After the growing seasons of 1938, 1939 and 1940, measurements were taken of total true heights and stem diameters at heights above ground of 1.5, 4.5 and 7.5.

Average diameter and height values for groups of 24 pruned and 24 unpruned trees, and values appropriate for determining significance of differences are presented in Table I. There is no evidence of non-uniformity in size

of trees as of the end of 1938. During the next two growing seasons diameter growth at 1.5 and 4.5 feet was markedly decreased by pruning, but diameter growth at 7.5 feet and height growth were not significantly affected by pruning.

Table I.—Average values for initial size and growth for 2 seasons of short leaf pine.

Diameter and height measures.	Unpruned trees.	Pruned trees.	Difference between unpruned and pruned values.	Attaining level of significance (P=0. 05).
Initial tree size, April 1939 ..				
Diameter at 1.5 feet in inches ..	2.13	2.09	0.04	0.14
Diameter at 4.5 feet in inches ..	1.27	1.28	.01	.15
Diameter at 7.5 feet in inches ..	.44	.47	.03	.10
Total height in feet.	8.68	8.81	.13	.43
Increment through 1939 & 1940 seasons				
Diameter at 1.5 feet in inches ..	1.04	0.86	0.18	0.12
Diameter at 4.5 feet in inches ..	1.05	.93	.12	.11
Diameter at 7.5 feet in inches ..	1.01	1.05	.04	.14
Height in feet ..	4.17	3.87	.30	.43

(b), *New Forest, Dehra Dun, India.*

An account of the interim results of a small-scale experiment conducted at the Forest Research Institute is given below. The experiment is located in compartment No. 2 of the experimental garden at New Forest, Dehra Dun and was commenced in March 1939.

The species is *Pinus longifolia*, which was raised by patch sowings made on the 3rd July 1932 at a spacing of 5 ft.×5 ft.

The object of the experiment is to determine the effect of early pruning on height growth, if any, of *Pinus longifolia* plants in relation to different heights of pruning.

Before the commencement of the experiment the heights of all the individual plants in the crop were measured. The plants were then arranged in descending order of their heights and were thus grouped into 3 trees of initially comparable equal heights for the random application of the three following treatments :—

A. Pruning up to ⅓ total height of the plant.

B. Pruning up to ⅔ total height of the plant, modified to leave one proper whorl of branches even if below the 2/3rd height, the height of the whorl left being recorded. This was found on calculation to amount to 3/5th of the height.

C. Control (unpruned).

There were 43 groups each containing three trees. These were subjected to the above treatments in March 1939. Height measurements were recorded in November 1940 and again in December 1942. Diameter measurements were also recorded on each occasion of the recording of height measurements.

The average height increments are compared below :—

Treatment.	Average height in inches. March 1939	Average height in inches. December 1942	Average height increment in inches. March 1939-Nov. 1940	Average height increment in inches. Nov. 1940-December 1942.
A. ..	105.2	276.0	84.0	86.8
B. ..	105.2	273.8	83.2	85.4
C. ..	105.1	280.5	86.9	88.5

The following table shows the analysis of variance of the height increments for the two above stated periods :—

Source of Variance.	Degrees of freedom	Height Incremetns.					
		March 1939—*Nov.* 1940			*November* 1940—*December* 1942.		
		Sum of squares.	Mean sum of squares.	F.	Sum of sq.	Mean sum of squares.	F.
Blocks ..	42	946.5			17013.5		
Treatments ..	2	325.9	162.45	1.02	206.4	103.2	0.31*
Error ..	84	13401.8	159.55		27614.9	328.7	
Total ..	128	14674.2			44834.8		

* Not significant.

Height growth.

No significant difference in height growth took place because of the pruning done to 1/3rd and 3/5th of the height in a small plantation of *Pinus longifolia* 7 years old at the time of the treatment.

Diameter growth. It was not the original intention to study the effect of the treatment on diameter, although diameters at breast height were recorded. As the differences in height are not significant it is natural to turn attention to diameter growth. This has been subjected to the analysis of co-variance as follows :—

Analysis of co-variance of diameter growth.

Sourse of co-variance.	Degrees of freedom.	Sum of squares (1939).	Sum of products.	Sum of squares. (1942).
Blocks	42	46.1640	63.9463	102.6159
Treatments	2	0.043	.1325	4.4900
Error	84	2.4807	6.8675	43.4160
Total	128	49.6490	70.0405	150.5219

$$\text{Regression coefficient (b)} = \frac{6.8675}{2.4807} = 2.768$$

$$b^2 = 7.66, \quad 2b = 5.536$$

The regression is highly significant as shown in the following table :—

Source of variance.	Degrees of freedom.	Sum of squares.	Mean sum of squares.	F.
Regression	1	19.0117	19.0117	64.66
Deviation from regression ..	83	24.4043	0.294	
Total	84	43.4160		

The following table shows the test for significance for treatment and error only, with the reduced variance :—

Source of variance.	Degrees of freedom.	Sum of squares. (adjusted),	Mean sum of squares.	F.
Treatments	2	3.7917	1.8959	6.44 (highly significant).
Error	83	24.4043	.2940	
Total	85	28.1960		

The adjusted mean diameters are as follows.

Treatment			Mean diameter in 1939	Actual diameter in 1942	Adjusted diameter in 1942
A	..	..	2.27	4.44	4.44
B	..	..	2.26	4.16	4.13
C	..	..	2.28	4.61	4.64

The tests for the significance of the differences are summarised below.

Differences.		Critical value for significance at a level of	
		5%	1%
A—B = 0.31	..	.23	.31
C—A = 0.20	..		
C—B = 0.51	..		

A and C are significantly superior to B although the difference between them is not significant, in other words pruning to 1/3rd height in a *Pinus longifolia* crop of 7 years in age did not cause any significant difference in diameter growth at breast-height, but pruning to 3/5th height was responsible for a significant decrease in diameter growth in comparison both with the unpruned trees and the trees pruned to 1/3rd height.

Bole form. It was not the object of the experiment to study the effect of pruning on the form of the bole. However diameters at 1.5 ft. and 7.5 ft. from the ground were recorded in February 1943. The results of the analysis of these additional data are summarised below:—

Analysis of variance.

Source of variance		Degrees of freedom.	Sum of squares	Mean sum of squares	F.	Sum of squares	Mean sum of squares from	F.
			(at 1½ ft.	from gl.).	(at 7½ ft.	from	gl.).	
Blocks	..	42	112.3742			104.2370		
Treatments	..	2	5.6788	2.8399	4.40	2.4969	1.2485	2.54
Error	..	84	54.2229	0.6455	significant	41.3561	0.4923	not signi-
Total	..	128	172.2759		at 5% level.	148.6900		ficant.

Differences at 1½ ft. from gl.	Critical value for significance at 5%.
A—B = 0.29	0.35
C—A = 0.22	
C—B = 0.51	
C is significantly superior to B.	

The form of the pruned trees has tended to become more cylindrical, but as the data have been collected for the first time the results can only be regarded as indications.

This experiment is on a very small scale as has already been stated, but a certain number of useful deductions can be drawn for the guidance of future experiments.

The first indication is that pruning experiments must deal with the measurement of more diameters than those at breast-height to detect the effect of the treatments on the bole form.

Secondly for species for which pruning must be done to improve timber value it is nevertheless of importance to determine the pruning regime that can achieve the object without sacrificing diameter growth.

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A BRIEF NOTE ON THE REGENERATION OF SANDAL TO SUPPLEMENT EXISTING STOCK IN FORESTS OR TO REPLACE SANDAL THAT MAY BE KILLED OUT BY SPIKE

By Sri Rao Bahadur, M. S. Raghavan—Silviculturist, Madras Province.

(G/2471/Md., S/51, 52, 845/Md.—The position as regards the present stage of research on sandal spike is pointed out. Suitable localities in Madras for artificial stocking by sandal are suggested, as also siting of plantations. Resistant hosts are enumerated.

Artificial regeneration is unnecessary, where there is sufficient natural regeneration. Notes on the artificial regeneration of sandal, root-suckers, Taungya and dangers to which the crop is liable, follow.)

In spite of all the research work that has been done on sandal spike by forest officers and other scientists from the time of McCarthy to the present day (from about 1894 to date), our knowledge of the disease is very rudimentary. We are fairly certain that spike is an insect-borne virus disease. We have suspicions of the insect responsible for the transmission, though we have not yet succeeded in proving it guilty. We have tried for some time control methods for the eradication of spike. Though success on a very small scale by the research staff at Denkanikota has been achieved, and though some experienced forest officers hold the view that if the operation is carried out effectively by employing a large staff and labour force within a restricted period of fifteen days, the disease may be made endemic instead of epidemic in larger areas, yet most of the district forest officers who have had to carry out the control operations in large areas in their districts, have complained of the utter impossibility of mustering a sufficiently large staff and labour to carry out the operations efficiently to eliminate or control the disease. The control operations have therefore generally failed in practice. Mysore has given up research on spike; and we are spending only about four to five thousand rupees per annum against about twenty thousand that we were spending prior to 1934. However, until the vector is found, and then methods for its biological control worked out, I fear we shall be unable to prevent the incidence of spike, or eradicate it, once it has entered an area. Some therefore express the opinion, that sandal may become extinct in time.

I am aware that forest officers with a good deal of experience of sandal and spike, have criticised this pessimism, and hold the view that if suitable localities for sandal are not invaded by lantana or similar weeds, and if grazing is permitted, then the danger of sandal becoming extinct will not arise.

As a guarantee against the extinction of the species, though artificial regeneration in or near spiked areas may be unsafe, attempts to raise it in suitable localities (such as those to be found in the Udamalpet range of the South Coimbatore division, plains, foothills near Kodaikanal, Ayyalur of the Madura division and portions of the Tinnevelli district, where spike has not yet come in offer chances of success in the artificial regeneration of sandal, without risk of spike. Perhaps attempts may also be made in Bellary, Kurnool, Cuddapah, etc., though in these districts, the growth of sandal may be exceedingly slow.

The introduction of sandal in timber regeneration areas, fuel and bamboo coupes is not recommended, as it would be an "embar-

rassment there, and more bother than it is worth." It may however be introduced wherever possible along roads and footpaths mainly at altitudes between 2000 ft. and 3500 ft. where it appears to find the most favourable conditions for its growth.

Too much opening should be discouraged, as the little seedlings are very sensitive to drought, and readily killed by exposure to the sun. They like side shade, but soon die if they have overhead cover, as they are sensitive to drip and tend to damp off in the rains. They are also sensitive to waterlogging and in cold wet soil are apt to rot. In opening, the lines should run north and south so as to protect the young plants from too much exposure to the sun.

All forest officers know that it is a root parasite, and must have some vigorous hosts to live on. If it does not manage to fix on to another plant in the first few weeks of its life, it will die. Some species are considered good hosts, while others are considered as predisposing to spike. Though leguminous hosts are in general held to predispose sandal to spike, it has long been thought that *Cassia Siamea*, in spite of being leguminous, is a host which imparts resistivity to spike. Bamboo is recognised as a good host for sandal, and can easily be raised in places with rainfall of about 60″ or more. Success would probably be obtained by stump planting sandal stumps in bamboo clumps. *Cassia siamea* as a host tree may be recommended, not because it confers resistance to spike, nor on the ground that it is a good fuel, but because it is easily grown in several places, and in districts like Chittoor the leaves are salable as green manure leaves. *Dhall Cajanus indious* has been used as a primary host for sandal, but as it is supposed to make the sandal highly susceptible to spike infection, some authorities prefer *Ruta graveolens*, which though not growing as tall as *dhall*, forms a bushy growth, and is well haustorized; and is said to impart resistance to spike; the host itself being further resistant to browsing. It is said that sandal associated with it, also contains the same essential oil, and is not palatable to browsing animals. In Coorg, sandal has been observed to do well with teak as a host. In Honolulu, *Casuarina equisetifolia* has been found to be a good host. The following species have been considered in the Madras province as "resistant hosts":—*Azadirachta indica*, *Semecarpus anacardium*, *Strychnos nux vomica*, *Cassia Siamea*, *Zizyphus jujuba*, *Murraya koenigii*, *Erythroxylon monogynum*. *Cajanus indicus*, *Cassia montana*, *Acacia suma*, and *Pongamia glabra* are said to render the sandal susceptible to spike.

Natural Regeneration.—Sandal deprived of hosts does not seed at all or seeds only once a year, and then only sparsely. When sandal trees associated with a sufficiency of hosts seed, the ground under these trees has got a sufficiency of natural seedlings, indicating that sandal has reproduced itself satisfactorily. Sandal seedlings have also been springing up in the middle of bamboo clumps; but there is a risk that such sandal associated with bamboos may die, or get burnt, when the bamboo flowers and dies and finally gets burnt. In sandal areas, observations have shown that there is plenty of natural regeneration of sandal in such areas, and seedlings are to be found in and around bushes. Where there is plenty of natural regeneration, artificial regeneration is unnecessary, and our energies must be devoted to tending them, and protecting them against fire, drought, grazing, overhead shade, or too much lateral exposure.

Where the natural regeneration is insufficient, much can be done in the way of increasing the stocking by introducing stump plants of sandal in suitable localities. When sandal stumps are introduced, seedlings or stumps of host plants such as *Cassia siamea*, *Melia dubia*, *Dodonea viscosa*, should be introduced simultaneously, so that these may first be easily haustorized, and keep the sandal plant alive, till it haustorizes on other existing hosts in the locality. The stump planting may be done when the first monsoon showers occur. The Intermediate host plant should be planted in the same hole with the sandal stump.

Casualties may need replacement, and in areas of heavy rainfall, careful weeding is indicated. The weeds are best cut back, and not uprooted. But if the weeds are likely to give lateral protection against the sun, they should be left.

In hot districts, sandal requires overhead shade in the first three to five years of its existence, after which we should give it all the overhead light possible. This opinion however,

does not meet with universal support, as overhead *shade*, is considered to have a beneficial screening effect against spike.

Coppicing *Santalum album* to obtain regeneration has not been encouraging. Regeneration by root suckers however is possible.

Seed Collection Locality.—.In the annual report for 1940-41 of the Coorg forest department it was stated that seed from plantation trees was completely infertile, while seed from natural forest trees, gave 19 to 25 per cent germination.

A germination test with seed of Chittoor and Timor island origins, with five hundred seeds of each origin gave germinative capacities of 29 per cent, and 19 per cent respectively. The Timor island seed was considerably smaller than the local seed; the seed weights being 250 and 282 seeds per ounce with and without pulp for Timor island seed; and 140 and 195 seeds per ounce with and without pulp respectively for the Chittoor seed. Indian seed appears therefore to be preferable to foreign seed.

Seed Collection-Season.—Sandal seed collected from the spring and autumn crops from five localities, Coorg, Javadis, North Coimbatore, North Salem and the Nilgiris, have been tested by monthly sowings. It has been observed that the seed from Coorg, North Salem and the Javadis, gives better germination than seed from the other two localities.

In the period 1936 to 1939, the spring crop seed collected in March, was found to give better germination than the autumn crop seed collected in November. But in 1934-36, and in 1939-40, the autumn crop was found to give considerably better germination than the spring crop seed. Against this work of the research branch there is an independent observation by the D. F. O., North Salem division that the October seed gave a higher germinative capacity than the February seed. It may therefore be summarized that the autumn crop seed is better than the spring crop seed, though the spring crop seed is utilizable and should be used if the autumn crop seed is insufficient.

Seed Collection Storage.—Sandal seed is known to keep well for a considerable time varying from 8½ months to two years if kept in air tight tins or in gunny bags. Though sometimes seeds after two years have given 75 per cent germination, there is generally a rapid loss of germinative capacity after nine months so that storage for longer periods cannot be recommended. *Acorus calamus* powder seems to have been effective in protecting stored sandal seed against insects.

Removal of Pulp from Seed.—A large number of experiments done by the research branch have demonstrated that seed from which the pulp has been removed gave consistently better results than seed with the pulp on. The pulp should therefore be removed from sandal before sowing.

Nursery Work.—The preparation of nursery beds is normal, and no notes are needed. "In Coorg the treated seeds are to be dibbled in lines at right angles to the length of the bed (See Mitchell's sandal scheme for Coorg 1936). Three to four seeds should be placed at intervals of three inches along each line. *Dhall* seed should be sown broadcast over the nursery bed, to serve as a temporary host, and also to give side shade. Watering the beds is not essential in Coorg as the seedlings have the benefit of a full monsoon after the dibbling and are usually established before the next hot weather. The smaller seedlings which die back would probably come up again after the early rains in March. In some localities it may be found necessary to erect *pandals* (shade) about six feet over the nursery beds during the hot weather."

As *dhall* is considered to be a spike predisposing host, we may use some other species such as *Ruta graveolens* as an intermediate host. Experiments in Emmanur have indicated that in hot districts, *Santalum album* has a decided preference for shaded nursery beds.

It may be of interest to quote the prescriptions on seed collection from the Mitchell sandal scheme for Coorg. "Seed should be collected from healthy trees. The locality factors of the area where such seed have been collected should be recorded. Sandal seed should be collected in March and October. Experiments conducted in Coorg indicate that a higher percentage of germination is obtained from Coorg seeds when compared with that of Mysore or Salem seed. In April all seed should be immersed in water for 24 hours. At intervals the seed should be stirred. Seeds which are found floating on the top of water one hour after immersion should be skimmed off and

flung away. The remaining seeds should then be put out in the sun for one day immediately afterwards. After drying, the seeds they should be kept in tins till they are required. Towards the middle of May shallow pits five feet in circumference and six inches deep should be dug near the locality where it is proposed to do artificial regeneration. A layer of paddy straw half an inch thick is then introduced into the pit. Then sandal seeds are spread over the straw to the thickness of one inch. Another layer of paddy straw half an inch thick should then be spread evenly over the sandal seed. Each morning about two gallons of water should be sprinkled over the straw. At about mid-day the top layer of straw should be removed and the seeds left exposed to the sun till about 4 p.m. after which the half inch layer of straw should be replaced. This process should be repeated for about ten days. When it is seen that the radicle is projecting from the embryo, the seeds should then be removed and introduced into the nursery beds, which should have been already prepared.

Artificial Regenerations.—Although it has been shown under natural regeneration that in many places it reproduces itself very freely, natural regeneration has not always been satisfactory in stocking our sandal forests. In spite of its ease of germination, it is not an easy tree to raise artificially. It may be considered that the cheapest method of regeneration of any species is by direct sowing in situ. But such a procedure does not meet with success as a rule. It is possible that the absence of natural regeneration and the difficulty of artificial regeneration by direct sowing may be attributed to the seed lying on an accumulation of vegetable debris and leaf mould as is often seen in bamboo areas, and either not germinating at all in the first few days, and being eaten by rodents or the young radicle not reaching the soil, due to the interposition of the leaf litter and mould.

Several experiments done by the research branch, and by districts, have shown that the seed is easy to germinate if sown on the soil below the litter, but subsequently trouble starts, and lots of plants die back, so that by the end of the first hot weather after sowing, the survivals are generally discouragingly small. Direct sowing therefore appears to be unsuited to the rigorous conditions of our drier districts, where we desire to grow the species. But where conditions are satisfactory, the soil deep porous and moist, with a sufficiency of hosts, and good rainfall, it has been observed that the introduction of small propagation centres some thirty years back have resulted in the spread of sandalwood naturally through the forest.

Dibbling could not succeed in places where grazing is permitted, but might do so in selected hedgerows or in thin bamboo jungle provided cattle and deer can be kept out. Careful fencing will be an absolute necessity. A high host sandal ratio must be maintained, by keeping down the number of sandal trees per acre.

Perhaps it would be best to cut lines in areas suitable for sandal, through the forest at an interval of about a chain and running north south. The existing trees on both sides of this line would provide sufficient hosts. Sandal may be regenerated in these lines. If soil, and climatic conditions are suitable, direct dibbling in the lines, with suitable intermediate hosts, and rigorous exclusion of grazing will give success. But deer are likely to frequent these open lines, and do much damage.

Entire Transplanting has also been tried. An experiment in Kadri range has been reported comparing sandal sowings and transplanting, and the transplanting is reported to have given overwhelmingly better results in the shape of fewer casualties and more vigorous plants, and that this success is doubly assured if the transplants are watered in the first month after planting. In Iygoor 1941 regeneration area in Coorg an experiment has shown that medium and big sized transplants are preferable to direct sowing and stump planting. In Coorg, the Iygoor 1941 area further observation has shown that at the end of the third year, there appears to be more casualties in big nursery plants, and the stocking seems to have been reduced considerably. Stumping one year nursery transplants has given best results, and next are medium size and small nursery transplants. Sowing has definitely given poor results. In the Iygoor 1942 area, big and small nursery transplants have maintained their superiority both in stocking and height growth at the end of the second year. In the Iygoor 1943 area also at the end of the first year big and medium

size nursery transplants have given good results both in survival percentage and height growth.

On page 309 of the Indian Forester for August 1936 it is reported that in Honolulu, "a successful method of cultivation of sandal has been worked out. When the sandalwood seedling is from 5 to 7 months old it is transplanted into an individual container which is usually a rejected pineapple can with a 4 inch diameter. At the time of transplanting a few seeds of the iron wood (*Casuarina equisetifolia*) are sown in the container. The latter germinate and grow faster than the sandalwood, and are soon of sufficient size to act as host. The sandalwood roots attach themselves at several contact points to the roots of the iron wood by means of a tissue penetrating haustoria, through which nourishment is absorbed from the host. When about o ‹ ear old from seed, the sandalwood transplant (with its host in the same soil container) is carried to the final planting site, and with the least possible disturbance to the roots of each is carefully set in prepared holes in the ground." Planting by this method is reported to have given one hundred per cent success in Honolulu.

Experiments in our research branch have however shown that the entire transplanting of sandal plants raised in bamboo baskets resulted in only about 9 per cent survivals, showing that this method is not suitable under our climatic conditions for sandal.

Stump Planting.—In North Salem division where spike disease research is going on, a large number of sandal plants of known age are needed. Therefore an interesting technique of obtaining these plants has been worked out. Suitable mother trees are selected in the forest and all regeneration under them is pulled up (to ensure uniformity of age of the plants utilised). The ground is dug to a depth of about four inches. After the next seed fall a mass of regeneration comes up under the tree which is removed and stump planted as and when required. It is thus possible to get from natural regeneration a number of sandal plants of known age for stump planting by this method. 22 mother trees were selected in 1936-37, and the aggregate area under them of 3,183 sq.ft. was treated as described above in October 1936, the soil under each tree being raked up and the fallen seeds were pressed into the soil. In January 1937 an enumeration showed a total of 2,275 healthy seedlings under the 22 trees, i.e. 104, seedlings per tree, or roughly 1 seedling per 1 and $\frac{1}{3}$ sq. ft. of ground.

Stumps are made with 1″ to 4″ of shoot and 6″ to 9″ of root; and the stump is either planted near a suitable host in a previously prepared bed or planted with a host if the host is a bushy rooted species. For experimental work we use *Mundulea suberosa* which can also be raised by stump planting. In such a case the two stumps are tied together and planted. Between 1931 to 1935 sandal has been so planted and reported to have shown 85 to 95 per cent success.

Two hundred and ten stumps from $1\frac{1}{2}$ year old seedlings put out by the district forest officer North Salem division in September 1931 and watered on alternate days gave one hundred per cent success in April 1932. An experiment in stump planting of sandal done in North Salem division has given 98 per cent survivals after three years (in 1933-34) with an average height of 4 ft. 5 inches.

In an experiment done in 1928 in the Nilgiris it has been shown that sandal can be grown from stumps, preferably made from plants 3′ to 5′ high.

Sandal plants can be successfully stump planted in their first, second, third or fourth years of age. It is preferable to use years $2\frac{1}{2}$–3 old plants for stump planting. The stump is prepared in the same way as teak stumps leaving about an inch or two of the stem, and about 9 inches root. This length of root is not usually possible as the tap root of sandal is not sufficiently long. All side roots are clipped off. The stump thus prepared is planted with a primary host in a crowbar hole or pit as the case may be. The planting is done during the monsoon, and the soil is well-pressed round the stem so as not to leave any vacant space inside. Secondary hosts should be made available in the area sufficiently in advance.

Mitchell's sandal scheme for Coorg (1936) prescribes that only as much as can be planted for the day, should be taken out, and stumps cut. The stamps should be kept well covered in damp straw, and transported to the locality where they are required. But, as difficulty is sometimes felt in the districts of the Madras

province to supply their own stumps, an experiment was conducted to test if sandal stumps could be sent to distant places, without deterioration. A consignment of 400 stumps was sent from Denkanikota to Emmanur experimental garden early in the south west monsoon of 1935-36. The stumps were planted three days after digging up at Denkanikota and ten days after, half were watered, and half were not watered. Some were planted with established hosts, others were planted at the same time as good hosts, and again others were planted with previously sown *dhall*. The result was that not a single stump sprouted. The experiment was repeated during the north east monsoon with exactly the same result. Parallel with the repetition, similar sets of stumps were planted at Denkanikota after being kept from two hours to three days, and resulted in a fair success.

Experiments have however been continued and work done in 1936-37 and 1937-38 at Denkanikota, indicate that

(*i*) sandal stumps can be safely stored *in tins* for three weeks before planting and still give nearly as good results as fresh stumps,

(*ii*) stumps stored in *gunny bags* deteriorate very rapidly in less than a week,

(*iii*) watering the stumps in storage every alternate day is very beneficial,

(*iv*) sandal stumps can be sent to comparatively distant places without serious deterioration,

(*v*) packing in tight closed tins gives much better results than packing in gunny bags,

(*vi*) two and a half to three year old stumps give better results than one and a half to two year old stumps, and

(*vii*) the north east monsoon is a better time to send the stumps than the south west monsoon.

We have also found that at Emmanur where we had difficulty in raising plants for cutting stumps, stumps cut from natural forest plants in the local hills have given much better results than stumps obtained from Denkanikota, in 1936-37.

C. B. Chengappa writes that another method of stump planting, reported in Somwarpet range (Coorg) in 1934 is as follows :—By this method the plants are cut back, before they are dug up, and they are then dug up with a ball of earth, the roots being intact. The tap root may be cut out, if too long, the stump will then be planted with the ball of earth and tamped firm all round. By this method the stumps sprouted in 6 days, as against 24 days in normal stump planting in 1934 in that range.

The most suitable time for stump planting will vary with the locality ; and so no hard and fast rules can be prescribed. In Coorg it is the end of May or the beginning of June ; but in our sandal districts, the North East Monsoon may be preferable.

In planting stumps a crowbar hole must be dug of sufficient depth to allow the stump of sandal and of the host plant to be inserted up to the collum without bending the root of either. The stump should then be inserted in the hole, and the soil pressed firmly round.

Root Suckers—Sandal produces root suckers, if trenched round. It has been observed that if root suckers are planted out in propagation centres they will give as good or better results than transplants or stumps. Though root suckers succeed, an experiment in North Salem division in which 24 pieces of roots from $\frac{3}{4}$ to $1\frac{1}{2}$ inches diameter were planted monthly throughout the year, showed that planting root pieces is an unreliable method of regeneration, as the sprouting varied from 25 per cent in August and September planting to nil in other months. District Experiments show that sandal regeneration by root suckers can be obtained by trenching about eighteen inches deep, and that the largest number of root suckers are found on the uphill side of the parent tree, and that the tallest root suckers were also on the same side.

Tuckle Regeneration.*—"Sandal plantations have been formed in the Wynaad and Nilgiri divisions in 1930 and one or two subsequent years. The principal points in the system (*taungya*) are

(*i*) to regulate the felling of the unsaleable trees of the previous stand, entirely in the interests of the future crop of sandal.

(*ii*) to lop the branches of the trees left standing as much as the cultivators require,

*Tuckle is not an English words. Dr. Griffith considers that it is a Tamil word, and merely a dialect form of KUMRI It may even be KANARESE, as it is used on the TAMIL—KANARESE border.—*Editor.*

(*iii*) to cut all undergrowth, and burn the cut material, but to regulate the intensity of the burn sufficiently to ensure the growth of coppice from cut trees and shrubs,

(*iv*) to introduce sandal by sowing, at a sufficient number of stakes, evenly distributed to ensure getting the stocking required allowing for natural casualties, and a large reduction of crop when the sandal is 1 or 2 years old. Sowing has been done in successful plantations at 300 per acre.

(*v*) to sow with and around the sandal plenty of *Cajanus indicus* (*dhall*) to serve as primary host and to protect the sandal from browsing. (In the localities where such sandal plantations have been made, *dhall* will live for 2 or 3 years and attain a height of about 6 feet). It is important however to remember that *Dhall* renders sandal parasitic on it very susceptible indeed to spike disease.

(*vi*) to complete the plantations by introducing a quick growing easily established species to serve as secondary host where the growth of coppice is inadequate. Where sandal has been sown at 300 stakes, secondary hosts have been introduced at 900 stakes per acre.'

G. C. Robinson, writes in 1936 about the Muthanga sandal plantation of 1930.

"This plantation of 1·4 acres in extent raised in a *ragi tuckle* is a fine success. There are plenty of big trees left, enough in fact to have been the ruin of the *ragi*, and there is also plenty of coppice and bamboos which have come in later and the *Erythrina* cuttings which we put in to serve as additional hosts have also done well. All the sandal present are very flourishing; but there should not be two or three stems in a cluster, nor, where the stems have forked low, should more than one be allowed to remain. Surplus stems should be cut out and no sandal should have another within five feet of it. For the present a stocking of 100 to the acre will be ample. Later on, it may be necessary to reduce it further. Apart from climber cutting no tending is required, nor need money be spent in future on the fence."

Reporting on sandal *tuckle* on an area of 24 acres in the Mudumalai range of the Nilgiri district done in 1930-31, the district forest officer writes: "It appears that sowing early in May gives excellent germination with untreated seed and that *Jatropha* and *Erythrina* can be introduced easily as cuttings. On the other hand there is much reason to doubt that the tuckle will come to anything unless fenced against dear. Lantana surrounds the area and the expense of keeping it out will be very heavy, but if the money is not spent for this purpose the area will revert to a sea of lantana."

Four experiments were done in 1930-31 and 1931-32 in the North Coimbatore division (Satyamangalam and Talaimalai ranges) on the raising of sandal in association with *dhall* by *kumri*, *Erythrina* cuttings being put in after harvesting the *dhall* and *ragi*. The experiments have shown that sandal can be raised by the method as small plantations, but unfortunately wild elephants have damaged two of the experiments. Where there are no wild elephants the method holds out promise of success. Sandal seed was sown at the stakes.

Dyson, in C. C. P. No. 199/17-4-40 in the Inspection notes of Kollegal forests writes that his personal opinion is that sandal sowing in bushes and strip regeneration should not continue. Where *kumri* is possible and unobjectionable, sandal *kumris* raised with resistant hosts are worthwhile on a modest scale at first.

Kumri or *Taungya*, where the soil and rainfall are suitable, where *Kumridars* can be got, and where fencing is possible against the smaller game and cattle, and where damage by wild elephants is not anticipated therefore appears to be a promising method of sandal regeneration.

Dangers to which the Crop is Liable.—It is practically impossible to prevent grazing in sandal regeneration areas if they are situated near villages, without *kumri*, and it is therefore essential to fence the entire area or individual plants or groups of plants according to the lay out of the regeneration. This fencing may have to be maintained for a sufficient time,

as the sandal is slow grown, the period for such protection may be about 10 years. If grazing can be prevented by legislation and closure to grazing of blocks where the sandal is regenerated the fencing may be dispensed with.

Damage by elephants can be serious, and no fencing will be sufficient protection, while trenching will be costly. Fencing may not be effective against rodents which carry away the seed, and small game such as mouse, deer or game like deer and *sambhur*, which nibble at the seedlings or bark them.

Damage by men who remove the bark for chewing, is also to be contended against.

Lantana is a source of danger, as it will spread fire, and predispose the sandal to spike.

Very recently a fungus attack, which discolours the heartwood, and makes it spongy, has been observed by the mycologist of the forest research institute, Dehra Dun.

The greatest danger of all, yet not completely understood, which bids fair to wipe out entire areas, is the spike disease.

J. E. M. Mitchell has written in 1934 "After taking everything into consideration, the costs of establishing sandal plantations *i.e.* (i) raising sandal plants, (ii) weeding for first three years, (iii) tending every two years thereafter, (iv) fire protecting, (v) cost of fencing (vi) cost of establishment,................ ....one cannot be favourably impressed by propagating sandal plantations, especially as spike might wipe out all that has been done, and also one cannot foresee the market rates of sandal 60 years hence, especially as the British pharmacopoeia has accepted Australian sandal oil which is cheaper than South Indian oil.

However rising prices for our sandalwood seem to indicate that in spite of all substitutes, there is a demand for sandalwood. Sandalwood may therefore be regenerated artificially in suitable places. The localities must be far from spiked areas, and not in the line of spread of spike. Even in suitable places initial experimental work should be on the smallest scale possible. I should not recommend a larger area than one acre at the most in each locality. If our experience proves the success of operations in the locality, we may expand further.

Though sandal stumps can stand transport to distant places, I recommend that a start be made at such places by starting a nursery, for which seed may be obtained from natural forests in Coorg or Javadis. There is no need to insist on seed being from spike free areas as the disease is not communicable by seed. The regeneration may be in lines one chain apart, 10 ft. wide, cut north to south, in existing forest, not required for exploitation for timber or fuel. The elevation should be about 2,000 to 3,000 or 1,500 to 3,500 ft. above sea level. The introduction of sandal should be by stump planting, with simultaneous introduction of primary hosts. Planting in the north-east monsoon is indicated. 1½ to 3-year old stumps are best.

It will be an advantage to combine sandal with a *kumri* crop, provided conditions are satisfactory. Host species in sufficient numbers should be raised with the sandal.

I recommend replacement of casualties as often as necessary in the first two years when moisture conditions are satisfactory. Normally weeding must be by weed cutting, retaining weeds on the sunny sides to protect the sandal plants against sun scorching.

SAL NATURAL REGENERATION IN THE UNITED PROVINCES

By D. Davis

Conservator of Forests, United Provinces.

(S/5/U.P.—Important points relating to the natural regeneration of Shorea robusta from the article of January 1944 are re-emphasised and certain aspects of the problem of natural regeneration of this species, not realised, ignored, or misunderstood, are elaborated.)

An article by the writer under the above heading appeared in the January 1944 number of the *Indian Forester*. Last season, the winter of 1946-47, he returned to the *sal* (*shorea robusta*) forests of the U. P. after an absence of about 4 years and was very disappointed with the progress of natural regeneration, particularly in Haldwani and Ramnagar divisions of the Western Circle, where most of the natural regeneration experimental work has been carried out and which the writer knew intimately between 1937 and 1942. Generally speaking there appears to have been no progress during the last 4 or 5 years; a few small patches here and there have definitely progressed, but most of the areas have remained static or deteriorated. He now wishes to record what he considers are the reasons for this poor progress and what should be done to remedy the present state of affairs and to improve our technique in future. The views expressed in the article of January 1944 still hold good in almost all respects and it is considered that if the technique outlined therein had been followed, results would have been infinitely better. The present article will repeat and re-emphasize certain important points from the previous one, but the writer will also elaborate certain aspects of the problem of *sal* natural regeneration, which in recent years do not appear to have been realised, or have been either ignored or misunderstood. As remarked in the earlier article, most of what has been written about *sal* natural regeneration in the United Provinces has referred specifically to the Bhabar B-3 *sal*. Present remarks refer largely to this type, but where the drier type is mentioned, this is A-2.

2. There are two definite stages in the progress of *sal* natural regeneration :—

(*a*) From germination up to the large-leaved whippy or small woody stage.

(*b*) From the time plants have reached the large-leaved whippy, or small woody stage, and are ready to grow up fairly rapidly, given the necessary light and protection from fire, frost and deer browsing, until they have reached the pole stage and are safe from frost and deer.

3. In plantations stage (*a*) is very short, provided all goes well, and may be said to be only 2 or 3 years. This is because intensive soil working enables the seedling to develop a good root at once, so that it rapidly becomes strong enough to go on increasing in height every year without dying back at all; intensive rains weeding in the early stages and freedom from overhead shade are also necessary to obtain the best results, though the latter can only be given where there is no danger from frost. Complete exposure to the hot weather sun is apt to be dangerous; the only reason why more young seedlings in plantations do not die of exposure to the sun and drought is because intensive soil working enables them to develop a strong root in the first year.

4. Under natural conditions in the forest, stage (*a*) is generally a long one and may be anything from about 8 to 20 years or more. Without soil working seedlings get a bad start and it takes them many years to develop a sufficiently strong root system to enable them to go ahead without annual dying back. In these early stages they are also not vigorous and strong enough to withstand too much exposure to the hot weather sun. We should not, *therefore, give them too much light* and expose them to the danger of damage or death from drought. Once stage (*b*) has been reached, however, *much more light can and must be* given, as drought damage is only likely to occur in very exceptional years.

5. The writer has for years emphasised the importance of retaining miscellaneous

species in considerable numbers in the canopy in *sal* natural regeneration operations. For stage (*a*) a considerable amount is required, if we are to obtain ideal conditions, and both upper and lower middle storey and an underwood of shrubs are required. What is wanted is a mixture of miscellaneous trees and shrubs of all heights. When the upper canopy of *sal* is opened, as it must be, these miscellaneous species are essential both to protect the *sal* plants from drought and to prevent the ap-appearance of excessive grass or low spreading weeds (*e.g. Ageratum*). Sufficient light must, of course, be given for the *sal* seedlings to survive and develop, but in stage (*a*) it is seldom that more than a fairly light selective cutting of shrubs and lower middle storey is required. Annual or periodic burning will also generally be required in stage (*a*), except in areas of a rather dry type. This burning is beneficial provided miscellaneous trees and shrubs have been left in sufficient numbers; otherwise it is liable to intensify drought damage.

6. Once stage (*b*) has been reached and the *sal* regeneration is ready to go ahead, it must be given much more light. But unless it is in the really strong woody stage and there is not much danger of frost, it still needs a fair amount of protection and in addition to the overwood it will be safer to leave a certain number of miscellaneous species in the middle storey, though clean cutting of the lower shrubs and undergrowth will now be required annually, and is most beneficial if done in the rains.

7. The main faults in past treatment of our regeneration areas are given below:—

(*i*) Too heavy opening of the upper canopy for stage (*a*). This is especially disastrous when accompanied by almost completed removal of the miscellaneous middle storey. Fortunately this has not been a common fault, but there are a few bad examples. The result, especially where shrubs have also been clean cut annually, is a sea of grass and no regeneration, as whenever seedlings appear, they die of drought before they are a year old.

(*ii*) Clean cutting of all shrubs and undergrowth every year in areas in stage (*a*). This was done almost everywhere four or five years ago. During the last few years attempts have been made to allow some shrubs and small trees to grow up as an underwood and middle storey, but the number left is quite insufficient, and to all intents and purposes almost clean cutting of shrubs and undergrowth has continued up to this year. The result of this has been that young seedlings die of drought and older plants are affected by drought and exposure and do not develop properly. The areas have also been invaded either by excessive grass or by low herbaceous plants such as *Ageratum*, and both these are harmful to *sal* regeneration. The only possible remedy now is to let a large number of the shrubs and small miscellaneous trees grow up again, taking care, however, not to go to the opposite extreme and let them get too dense.

(*iii*) Too early removal of the overwood in stage (*b*). This has been done in a few places and as was to be expected the result was bad frost damage and great increase of grass. In one place there was a bad fire made much worse by the heavy grass and a large area has been converted into a *chandar* with frost cutting back the *sal* shoots whenever they get above the grass. The remedy is the same as under (*ii*), though it will take a long time.

(*iv*) Failure of fire protection, which is so essential in stage (*b*). One important area has suffered 2 or 3 times from accidental fires and each time the regeneration has received a bad set back.

(*v*) Neglect of essential shrub cutting in stage (*b*). This and the fires mentioned under (*iv*) are partly due to the preoccupation of the staff on the intensive exploitation necessitated by the war. They must be mentioned, however, because they are important reasons for some of the poor progress.

8. In general the writer considers that the most important and most general mistake in our *sal* regeneration work in recent years has been the marked tendency to treat regeneration areas in stage (*a*) as if they were in stage (*b*). This refers not so much to the opening of the upper canopy as to the treatment of the miscellaneous middle storey and particularly the lower middle storey and undergrowth. It appears to have been thought that removal of most of the miscellaneous middle storey and annual clean cutting of shrubs and grass would induce recruitment and enable the regeneration to develop and grow up to the large-leaved whippy stage more rapidly. Actually this treatment is only beneficial in stage (*b*) and is the worst possible treatment in stage (*a*), as explained in para 7 (*ii*) above.

9. Another tendency that should be guarded against is to start stage (*b*) treatment too soon. It is fairly certain that under natural conditions *sal* plants must spend a considerable number of years going through stage (*a*) before they can be expected to reach stage (*b*) and be ready to go ahead. We can help them to progress more rapidly by careful control of the canopy, but it is no use expecting them to shoot up before they are sufficiently developed and ready to go ahead. If we start the intensive stage (*b*) treatment too soon the only result is stagnating regeneration and waste of money.

10. To summarise what it is considered our technique should be in future :—

In stage (*a*).—After opening the canopy to the necessary extent, taking care not to remove too much of the miscellaneous middle and lower storey, burn annually or periodically (except in the drier types of forest) as considered necessary. Shrub cutting should be done with great caution. Shrubs should *never* be clean cut, but it may often be necessary to thin them out ; in the drier areas practically no shrub cutting may be required. Even if shrub cutting is required, it may not be necessary to do it every year. It is important to examine every area each year before deciding what treatment is required. A further opening of the upper canopy and possibly of the middle storey will probably be required before regeneration reaches stage (*b*), but the writer repeats his firm conviction that *sal* plants in stage (*a*) need a considerable amount of shade and particularly the shade from miscellaneous middle and lower storey and scattered shrubs. They develop quite happily to stage (*b*) under a considerable canopy of this sort, always provided it is not allowed to become *too* dense.

In stage (*b*).—When satisfied that regeneration is really ready to go ahead, a further opening of the upper and middle canopies should be made. One more burn after the fellings, and then strict fire protection with annual clean shrub cutting, preferably in the rains, and a game proof fence, if deer browsing is likely to be bad. Stage (*b*) operations are easy compared with those for stage (*a*), so there is no need to elaborate further, except to emphasise once more that it is a great mistake to start these stage (*b*) operations, and particularly the clean shrub cut, until the regeneration is really ready to go ahead. In this connection, it may be remarked that the drier the type of forest, the slower will be the development of the *sal* plants up to stage (*b*), and the writer thinks that in most of the drier areas it will be necessary to wait till the plants are in the small woody stage before starting stage (*b*) treatment.

11. Finally a word about expense. In para 3, it is shown why stage (*a*) is a very short one in *sal* plantations, at any rate in successful plantations. It may be asked why we should not do something more to reproduce some of the plantation conditions in our natural regeneration work. This would mean soil working, which would be very expensive and would in 9 cases out of 10 be more or useless unless we also did broadcast sowing of *sal*, as we could not depend on natural recruitment in a particular area in the year of soil working. I think it is possible we may find soil working and broadcast sowing worth doing, especially in the drier types of forest. It was done on a small scale in Jaspur 41 in Ramnagar division some years ago and it is considered that we should experiment further. But until it has been proved to be worth doing on a big scale we must continue to rely on natural regeneration without soil working.

As stage (*a*) is generally a fairly long one under natural conditions, we should try and cut down expenditure during this stage to the minimum. Apart from the reasons already given in this note against clean shrub cutting during stage (*a*), it is obvious that we cannot afford to spend Rs. 10 to Rs. 15 per acre per annum on this for 10 to 15 years until stage (*b*) is reached, especially when we shall generally have to spend even more than this during stage (*b*), or at any rate during the first five years or so of this stage. As clean shrub cutting in stage (*a*) will definitely prolong this stage indefinitely, it is even more important to give it up at once.

THINNINGS APROPOS SNOW-DAMAGE IN CEDRUS DEODARA AND PINUS EXCELSA CROPS

By Jagdamba Prasad, B.Sc., LL.B., P.F.S., Statistical Assistant (*Silviculturist, F. R. I., New Forest, Dehra Dun*).

(G/255/R.I., S/7 & 85/R.I.—Causes of snow-damage in Cedrus deodara and Pinus excelsa crops are examined. The remedy suggested is light and frequent thinning.)

When out measuring sample plots in the Chakrata forest division in May and June 1947, the writer had occasion to make a few observations about damage to the *Pinus excelsa* and *Cedrus deodara* crops said to be due to snow. The matter first attracted attention in sample plot No. 9 of *Pinus excelsa*, a mile from Kanasar. On referring to the records of this plot the writer found notes by two former central silviculturists, which need publicity in this connection.

Serious damage from snow was noted by MARSDEN in 1916, 46 stems out of 123 having been broken or uprooted. The trees then had an average diameter of 9.7 in. and an average crop height of 71 ft. Snow damage was less at the edges of the plot where surrounded by other crops and worse in the centre where the effect of thinning was considered as felt. Girth of the trees was considered to have little to do with the damage.

It was stated that the degree of severity of thinning in *Pinus excelsa* might depend on steepness of the slope. In the plot concerned the slope was 32°. Snow collects on crowns and if the slope is steep tends to slide downwards bending over the trees. If a gap is present below, this bending process continues till trees are broken or uprooted. If no gap exists, further bending is checked by support of trees below.

The reference to the crown and then to the ground slope is not quite clear in this note but considering that the remarks were copied into the file by a clerk, the possibility of an omission of important words cannot be ruled out.

In 1928 CHAMPION remarked in the same connection that the case for the thinning being the cause of the much greater snow damage as compared with plot 10 was not as clear as might have seemed. The plot includes the marginal trees adjoining open ground both along the N. W. and the S. W. The greater part of the damage was below the big branchy trees 3, 17, 18 at the top edge, themselves unharmed. On the other hand plot 10 is surrounded by forest on all sides and the trees at the top have relatively small symmetrical crowns and stand on quite gentle slope. Finally damage in adjoining unthinned forest of very similar age and type was just as bad—often more so.

MILWARD'S note in the *Indian Forester* of June 1928 gives a different outlook to the snow damage of the *P. excelsa* plot. The damage was of 1911. The rain gauges recorded 30 inches of rain and wet March snow at higher elevation and there was an unusual number of heavy storms. It was quite an unusual amount of precipitation. Thinnings in the plot were only coeval but not a cause of the damage necessarily, as the damage was very widespread.

Besides thinnings were not considered profitable and were not done in those early days in these forests and sudden opening by late thinnings can be a predisposing cause for the phenomenal damage.

From observations of the kind of injury and the position of the trees in the crop in *Pinus excelsa* and *Cedrus deodara* plots it appeared that snow damage was due to the collection of a heap on a branchy leader and its subsequent fall again in a heap with wet snow, as is common in March, on the neighbouring tree that could not sustain the shock. Thinnings are thus a necessity, because it is only by removing such trees and eliminating crowding that damage of this kind can be obviated.

Young pole crops, however, need more careful tending, because if suddenly opened out after growing in a dense condition for some time, they will suffer heavily. Thinnings should begin early in such cases, carried out lightly but frequently.

A study relating to snow damage in plantations (*Journal of Forestry*, June 1936, page 618) indicated that snow damage in plantations could be greatly offset and possibly eliminated by judicious thinning to prevent the formation of unsymmetrical crowns on conifers.

The recommendations for snow damage prevention therefore are *light and frequent thinning.*

DRUG INDUSTRY IN KASHMIR

By Mr. M. L. Mehta

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(G/92/I.S., S/3 & 63/I.S.—Medical plants of Kashmir were over-exploited and as a result discredited and undervalued as regards their alkaloid contents. Suggestions for future management include the establishment of plantations and calls on natural supplies at longer intervals. Silvicultural research is indicated for the former, towards which a beginning has already been made.)

Kashmir is rich in drugs. Many valuable drugs are found growing wild in these forests. To mention but a few: Belladona, Podophyllum, Aconites, Kuth, Colchicum, Artemisia, Datura, Hyocyamus, etc. are amongst valuable medicinal plants. There are other economic plants like Pyrethrum, Digitalis purpurea and Digitalis lanata, which though not growing wild, have been successfully introduced into the state and are flourishing well.

Many of these druge are listed in the British Pharmacopea. However, due to indiscriminate and many a times adulterated supplies and lack of authoritative propaganda the quality of many of these drugs is not considered to be of a very high order. Thus in the British Pharmacopea the alkaloid content of Indian Belladona is standardised at 0.15%. Actually the alkaloid content of this drug has been found to be as high as 0.65%. The poorest sample gave 0.30% as its alkaloid content. Similarly in case of Henbane, the drug grown at Saharanpur, Peshawar and Lyallpur gave 0.03, 0.04 and 0.025% as its alkaloid content while that in our nurseries gives 0.084% as its alkaloid content. There are other drugs which are not standard British Pharmacopea drugs, though in the trade these are being used and are actually found to be good substitutes for the British Pharmacopea drugs. An example may be cited of Valerian wallichil. The British Pharmacopea is Valerian officinalis but the Indian Valerian is being used with no mean results.

Since the Government enjoys a monopoly of these drugs here, it is up to it to see that these discordant features are removed and a good name in the trade, both Indian and foreign, is established. Though even at the present Kashmir is definitely more advanced than many other states and provinces as far as the utilization of this class of minor forest produce is concerned, yet quite a lot remains still to be done. In this article the writer would endeavour to suggest some of the more relevant lines upon which progress could be made, not only by Kashmir but generally elsewhere in India.

Past Methods of Extraction.

Most of the drugs are found wild. The D. F. O., Utilization Division, who is also in charge of the sales trade, used to assess the total quantity of drugs required. He used to distribute this total indent to different territorial divisions. The territorial D. F. O. used to get these drugs extracted either by giving out local contracts or used to get the drugs extracted departmentally. Some rules were laid down regarding extraction. Thus after every five plants collected one was to be left as such for future propagation of the drug. Some definite season was specified for collection. Plants below certain age were not to be plucked. At some places the more keen D. F. Os introduced rotational closure schemes under which certain areas were not to be tapped and were given a recuperational rest.

After the collection was made the territorial divisions used to send these drugs to the central godowns of the utilization division, where these were sorted out and cleaned and afterwards marketed.

On paper the whole procedure looks alright. But it has many loopholes. It was noticed even before the war that every thing was not alright with our methods of extraction. However with the break of hostilities the demand on these drugs became heavy and it was increasingly felt that many of our important drugs were reproducing themselves at a rate much lower than at which the extraction was taking place. The yield of our most promising areas was depleted so much so that many of our important drugs became almost

extinct. At the same time the quality of our drugs deteriorated at an alarming rate. These facts are well illustrated by the report of the Director, Drug Research Laboratory, given below. The whole of the produce of belladona was utilized by this department.

Year.	*Roots.*	*Leaves.*	*Total.*	*Average alkaloid content.*
	Mds.	Mds.	Mds.	
1938	45	427	472	0.45 to 0.65%
1939	82	308	390	0.45 to 0.65%
1940	395	1645	2040	Not known.
1941	625	1000	1625	Not known.
1942	398	536	934	0.30 to 0.35%
1943	417	590	1007	0.30 to 0.35%

It was found that the provision made for retaining a certain percentage of plants was never actually implemented. All plants available were collected at random irrespective of their age and size. Collections were made according to the convenience of the collectors. Due to increased works, the forest staff could not supervise the extractions properly. Adulteration became rampant though quite a large extent was sifted out at the godowns afterwards.

It was mostly at this stage that many schemes for rotational closures were introduced. However these also did not prove to be entirely satisfactory. Illicit extraction from closed area did take place by the neighbouring contractors. In case of costly drugs, like Colchicum, smuggling by post also was resorted to. Apart from these limitations found in practice, there are some inherent defects in the system adopted. The system cannot be supervised properly and the above enumerated results are the outcome. Ruthless exploitation is practised and there is a gradual extinction of valuable drugs. Being spread over, the quality of the produce that is collected finally is not uniform—a great set-back to the establishment of a reputation for the produce unless it is systemically graded. But the crowning defect in the system is that the quality of the produce cannot be improved either through the improvement of the nature of the plant or through its nurture, through gradual selection and isolation of better strains or to go a step further by breeding of better plants. Actually some workers have been able to multiply the yield of some of our drugs manifold by isolation of better strains. Through adaptation of better methods of cultivation yield can be definitely enhanced.

Suggestions for the Future.—First and foremost would come the correct assessment of sustained consumption of the drug. This could be done by the utilization division in consultation with the Drug Research Laboratory. Kashmir is fortunate in having a definite consumer of drugs in the Drug Research Laboratory. But apart from that also there are big buyers of these drugs in India and abroad who could be contacted for assessment of their approximate annual demand.

In view of the past experience and lack of uniformity of produce it would be preferable to make the sale on active principal content basis rather than on the gross weight of the drugs. A lot of propaganda by the utilization division requires to be done and the low figures in the British Pharmacopea relating to our drugs require to be materially altered if the fair name of our drugs is to receive its due reputation.

Having assessed the approximate annual consumption, the next item naturally is the production of the drug. It is suggested that in future more drugs should be cultivated rather than collected wild. Raising of these drugs artificially would be attended by many advantages. A sustained annual yield could be maintained. Best methods of cultivation could be incorporated. Better strains of plants could be isolated and grown. Collections could be made at the proper time. The yield in terms of active principal content could be increased manifold.

It may be argued that the cost of production would be higher. In my opinion, however, the manifold advantages that are attendant upon this method as also the increased yield of active principals which could be incorporated, would definitely more than counterbalance the increased cost of production. As far as lands are concerned, I believe that enough cultivable lands can be made available in our forests.

At the same time the natural output of our forests in these respects should not be

neglected or ignored. The present method of making indents upon territorial divisions should be continued. However these demands should be much lighter and should be made, say, once in every three or four years, thus affording sufficient time for the recuperation of the extracted areas. The produce thus collected being not an outcome of ruthless exploitation and indiscriminate collection would not be very poor. However, this stuff should be graded by the utilization division, and all grades should be properly, but separately, analysed and advertised accordingly.

Having agreed to the above-mentioned principles, research on proper methods of propagation and cultivation of these drugs, best place and altitude for raising these drugs, best method of collection, drying, storage, etc. have to be determined. Further isolation of better strains and breeding of better types would have to be brought about. In the beginning experiments would be naturally restricted to the more valuable drugs but in view of the time that is taken in research of such nature, experiments on other drugs should also be started. At the same time cultivation of the more valuable exotic medicinal plants should continue. Research on many of these aspects has already been started by the research division and is proceeding at a good speed.

SUMMARY

C/1133.143/5 and 6/B. and O./C. P. S/5 and 6/B. and O. and C. P.

Discusses the problems connected with the natural and artificial regeneration of Champion's A-3. Dry Peninsular Sal. Natural regeneration, though scanty, is probably adequate both in Bihar, Orissa and the Central Provinces. The principal adverse factor is drought. Establishment period would seem to be very long and it is important to have advance growth on the ground at the time of regeneration operations. Shade is essential for successful regeneration and a mixture of low and high shade seems to be beneficial. Shrubs and undergrowth rarely cause serious difficulty, neither do climbers, but grass may be detrimental. *Flemingia chappar* has been suggested to be a good nurse. Burning is unquestionably detrimental in every phase of regeneration. Grazing is also probably an adverse factor, but much is not known about the effect and manipulation of soil. Coppice regeneration is generally good.

Artificial regeneration is of subsidiary importance. There do not seem to be any large plantations, neither is there any record of taungya plantations, which have however been recommended for Bihar and Orissa. Direct sowing is the only method of propagation. Weedings, early tending and soil working are important. *Tephrosia candida* may be a good nurse crop. Very little information is available about costs.

Keeping a mixture of species at the time of thinnings would seem to be favourable to regeneration.

Acknowledgment

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THE NATURAL AND ARTIFICIAL REGENERATION OF DRY PENINSULAR SAL

By R. Chakravarti, B.Sc.

Introduction

CHAMPION in his *Regeneration and Management of Sal* has classified his type A *Dry Sal*[4] into three subtypes, *viz:* A-1 *Dry Siwalik Sal*, A-2 *Dry Gangetic Alluvial Sal* and A-3 *Dry Peninsular Sal*. This paper deals with the problems connected with the natural and artificial regeneration of A-3 Dry Peninsular Sal.

Distribution and floristic composition

To start with, a few remarks about the distribution and ecology of Dry Peninsular Sal seem necessary. These are based on Champion[4], [5], unless otherwise stated. Troup[28] who has classified *sal* in a general way into two extreme types, moist *sal* and dry *sal*, with various gradations in between, observes that *Dry Sal* is characteristic of dry and often hilly country, denuded or hard ground and shallow soil. It seems to be generally associated with regions with a long, dry season. The rainfall is rarely over 60 inches, often under 50 inches, and may be as low as 35 inches. Mean daily relative humidity is under 60 and for March under 45. Soil drainage is very complete.

Dry Peninsular Sal is the most important *Dry Sal* type since it covers 95 per cent of the forests of Bihar and Orissa, most of the Eastern States and some of the Central Indian States. Sambalpur is typical, while Puri is a notable exception, and in Singhbhum the damp type occurs only in the valleys[20]. It also occurs locally in Bilaspur (Baloda) and South Raipur divisions of Central Provinces, in Midnapur and Bankura districts of Bengal (where these forests are not reserved) and locally in Madras, where it is not of much importance. *Bhabar* (*sabai*) grass is a characteristic associate. The typical quality is IV. The rock is crystalline with a dry shallow soil. *Anogeissus latifolia* and *Boswellia serrata* in the top canopy and *Gardenia* spp. and *Wendlandia exserta* in the lower canopy are the characteristic associated species. Among grasses, *Dendrocalamus strictus*, and *sabai* grass (*Eulaliopsis binata*) are characteristic. In Bihar and Orissa the dryness is more often due to edaphic factors often aided by unfavourable biotic influences. The elevation varies between 500 feet and 3,000 feet. The rainfall is not favourably distributed as the seven months from November to May have less than one inch monthly and October only two inches, the annual rainfall being from 45 to 65 inches. Temperatures run high and frost does not usually occur. *Sal* shows a distinctive preference for acidic soils. Locally *Cleistanthus collinus* is an associated species. Climbers are not usually prolific. Fire-protection is difficult so that most areas have been burnt at one time or another. The high percentage (80) of unsoundness in Sambalpur is attributed by some to the frequent hot fires. Grazing appears detrimental.

In Sambalpur the forests are situated on the plains and the hills and a number of blanks occur. Unsoundness as already mentioned, is prevalent. Both these are attributed to past cultivation which has disturbed, and will continue to disturb for many years, the drainage of the subsoil and aeration of the upper two to three feet of the soil. The blanks are often in long narrow strips, fifteen yards wide and resist natural regeneration. The commonest associated species are: *Terminalia alata*, *Anogeissus latifolia*, *Pterocarpus marsupium*, *Diospyros melanoxylon*, *Buchanania latifolia*, *Lagerstroemia parviflora*, *Gmelina arborea*, *Eugenia jambolana*, *Adina cordifolia*, *Dalbergia latifolia*, and *Mangifera indica*[9].

In Angul *sal* contributes a smaller proportion of the crop than the miscellaneous species and is only found in any quantity in the Raigoda and Bolong blocks. The floristic composition is as follows:—

1. Good quality *sal* forests: *Sal* forms the bulk of the crop, but generally not over 50 per cent of the stand. The quality is II in favourable localities, but is generally III. Associated species are (a) in the valleys, *Terminalia tomentosa*, *Eugenia Jambolana*, *Adina cordifolia*, *Boswellia serrata*, *Mitragyna parviflora*, *Lagerstroemia parviflora*, *Mangifera indica*, *Pterocarpus marsupium*, *Terminalia belerica*, *Miliusa velutina*, *Anthocephalus cadamba*, a few large *Anogeissus latifolia*, and large clumps of *Bambusa arundinacea*. (b) on the hill-slopes, *Ougenia dalbergioides*, (not

common), *Anogeissus latifolia*, *Lagerstoemia parviflora*, *Lannea grandis*, *Cleistanthus collinus*, *Schleichera trijuga*, *Madhuca latifolia*, *Garuga pinnata*, *Diospyros melanoxylon*, *Bridelia retusa*, *Dendrocalamus strictus*, etc. The underwood and undergrowth consists of such species as, *Cassia fistula*, *Diospyros montana*, *Glochidion lanceolarium*, *Polyalthia cerasioides*, *Mallotus phillipinensis*, *Flemingia* spp., *Casearia tomentosa*, *Holarrhena antidysenterica*, etc. Common climbers are, *Bauhinia vahlii*, *Combretum decandrum*, *Milletia auriculata*, etc.

2. This type consists of *sal* forests found on the sandstone formations in Simlipathar and Durgapur blocks. The crop is often very open and in places savannah-like. The average quality is IV. Following are the associated species: *Elaeodendron glaucum*, *Terminalia chebula*, *Morinda tinctoria*, *Emblica officinalis*, *Madhuca latifolia*, *Eugenia jambolana*, *Pterocarpus marsupium*, (small), *Madhuca latifolia*, *Flacourtia ramontchi*, *Miliusa velutina*, *Dalbergia paniculata*, *Ixora parviflora*, *Holarrhena antidysenterica*, *Woodfordia fruticosa*, etc. *Antidesma diandrum* is a common shrub. Climbers are not common. The common grasses are *Aristida setacea*, *Heteropogon contortus*, etc.[12]

Ecological status

Ecologically, this type is usually either an edaphic or biotic subclimax to moist *sal*.

On the other hand, the presence of sal is perhaps unduly emphasised in differentiating this type from the rest of the dry deciduous forests to which it perhaps stands the relation of a post-climax association on the moister or deeper soils.

NATURAL REGENERATION

General

According to Champion,[4] in dry *sal*, regeneration is almost invariably deficient, woody seedlings being found in any quantity in pockets of deeper and moister soil. It is generally noticed that there is better regeneration under shade, even *sal* shade, than in the open, loss of moisture from exposure evidently exceeding losses from root competition. Seedlings remain for a long time in the whippy stage, the rootstocks developing but slowly to the size necessary to produce an erect fleshy shoot. Burning is unquestionably detrimental rendering a dry locality even drier with consequent heavy mortality in recruitment and slower growth of survivors; it also results in further deterioration through soil erosion. Shrubs and undergrowth rarely cause difficulty—the reverse is often the case—but a grass mat may hinder regeneration and make fire-protection difficult.

The above remarks are generally in agreement with those of Troup,[28] who has also pointed out the detrimental effects of complete exposure and of fire. The hollowness of trees in dry tracts, according to him, is due to fire.

In the Bengal *Dry Sal* forests, regeneration is very poor largely owing to the excessive grazing and consequent hard dry soil. In Bihar and Orissa it has been recorded for Sambalpur that natural regeneration is almost invariably best where the density of the overwood is greatest—a feature evidently correlated with the dry habitat, where shade may more than compensate root competition in the matter of seedling establishment. In the same way *Woodfordia*, *Wendlandia*, etc., are clearly effective nurses for *sal*. The establishment period seems to be very long and for Palamau it has been suggested that 50 years may be too short! Seedling regeneration is adequate, though coppice regeneration is mostly relied on. As already stated, grass growth is inimical to regeneration possibly owing to effective competition for the limited available moisture, and locally bamboos quickly fill up any opening made for regeneration.[4]

The following further remarks apply specially to Sambalpur. Seedling regeneration is good except in grassy blanks and other flat areas where past cultivation and grazing have spoiled the natural drainage and looseness of the soil. It is naturally at its best where the soil and other conditions are favourable.[17]

Before proceeding further, the climatic factors that affect regeneration must be clearly kept in mind. The following remarks though applying specially to Singhbhum, will, it is hoped, be representative.

The principal adverse factor is drought. Annual rainfall is 55 inches in June to September. Even in this period dry weather up to three weeks is not uncommon. Thus the *sal* has to endure eight months of dry weather; and in April and May heat may be intense, the temperature rising up to 115 degrees.

Frost is unknown ; though dew deposits may be found in sheltered localities up to the middle of the day, but where there is no overhead cover. Retention of dew appears to be one of the reasons why other things being equal, aspects sheltered from the morning sun show the best regeneration.[10]

F. C. Osmaston[14] has discussed the relative importance of the different forms of regeneration—seedling, coppice shoot, seedling shoot, pollard and rootsucker—from the points of view of vigour, soundness, straightness and quality of timber. While recording that the regeneration of *sal* forests is entirely dependent upon the presence of advance growth at the time of regeneration fellings, true seedling reproduction being practically unknown, he emphasises that all existing *sal* forests, with perhaps a rare exception here and there, have originated from coppice either as seedling shoots, true coppice shoots or pollards. From the four points of view mentioned above, he recommends the cutting back of advance growth. He concludes that in order of importance seedling shoots follow seedling trees while being followed by coppice and pollard. The cutting back of established *sal* regeneration has accordingly been recommended in Nicholson's working plan for Sambalpur, in October or March, April and May as these are the months during which the raw shoots are produced with the greatest vigour.[13]

South Raipur experience also emphasises the importance of the presence of regeneration on the ground at the time of the regeneration operations.[2]

When can *sal* be said to have become established ? This is a very difficult question in view of the fact that *sal* is in the habit of repeatedly dying back. Neither from the unestablished condition alone, nor from the established condition alone can we assess the factors favourable for *sal* reproduction. Favourable conditions are therefore indicated by the presence on ground of regeneration in all stages.[20]

Natural regeneration by seed

As already mentioned natural regeneration by seed is the most important form of regeneration of *sal*. Various factors influence it and matters are further complicated by *sal's* notorious habit of dying back. In the regeneration of *sal* forests, however, the more violently and extensively we interfere with the natural course of events, the more likely we are to be preparing ourselves pitfalls and rude shocks which we may subsequently receive, often after a considerable lapse of time, from totally unsuspected directions.[8]

Seeding

The periodicity of good seed years seems to be four years for Sambalpur, as would be seen below :—[9, 28]

Good : 1904, 1908, 1912, 1920, 1922, 1924.
Moderate : 1905, 1907, 1909, 1910, 1913, 1915, 1917, 1918, 1921, 1925, 1926, 1927, 1929.

Bad : 1906, 1911, 1914, 1916, 1919, 1923, 1928, 1930.

According to Troup,[28] 1916 was a poor seed year following a period of abnormal drought. He again quotes a report from Santal Parganas, which states that 80 per cent of the fruit crop is blown down in the hot season before the fruit ripens and of the remaining 20 per cent only a small portion germinates. (Also see page 16).

Canopy

As already stated *Dry Sal* requires shade for successful regeneration. This fact is amply borne out by various instances recorded. Hole[8] observes that in dry forests where comparatively little damage is done by bad soil aeration and where seedlings suffer chiefly from drought, in the dry season side shade from the south may be beneficial, and it is possible that an east to west or south-east to north-west direction would be best for the strips (in the case of strip fellings) as this would afford the maximum shade from the hot midday or afternoon sun.

The strip fellings suggested by Hole, and which were tried in Sambalpur have, incidentally, been abandoned because they do not seem to have increased *sal* regeneration at all. In fact these strips probably hinder it by encouraging grass which responds at once to any clearfelling. Not only does grass drain away surface soil moisture very considerably, but it also increases fire damage.[17]

Makins[10] discussing *sal* regeneration in Singhbhum refers to the habit of local *sal* seedlings to establish themselves under heavy shade in every stage of development. *Sal* does not however regenerate under its own shade, the possible reason being drip, as suggested by Haines. This is interesting in view of Champion's observation referred to earlier,

and also Raipur experience,[2] which refers to the seeming habit of *sal* regeneration to grow and establish even under a very dense canopy below the parent trees. The habit of local *sal vis-a-vis* shade is again emphasised by the Provincial Research Officer, Bihar and Orissa.[20] Experiments conducted in Puri and Saranda conclusively showed, in the case of dry type of forests, that the most successful regeneration was close to a sheltered fence on the south-west boundary. "Whereas under humid conditions *sal* seedlings will survive in full light, on well aerated soil, under dry conditions they probably require some shade on the south-west". "Again, *Sal* regeneration only becomes established when it is under low overhead shade or when it is shaded from the afternoon sun on the south-west by low cover". The relative values as regards shade of *Wendlandia tinctoria*, *Anogeissus latifolia*, *Flemingia chappar*, and *Terminalia tomentosa* have also been discussed. Low cover is more effective than high cover. Why this is so is not clear. It may be due to differences of light; most low cover is deciduous and it therefore admits light in the *sal* growing seasons; but it is more probably due to the fact that low cover affords better shelter under dessication. Years of favourable rainfall in the hot weather (*e.g.* 1926) probably have a great influence on the rate at which seedlings become established.

The virgin forest conditions under which most of our forests grew up are stated to be ideal for the establishment of *sal* regeneration as they afford the necessary mixture of low and high cover. This point has also been emphasised in Sambalpur working plan.[17] *Sal* regeneration is greater and healthier where selection fellings have been made and where the canopy is irregular. A dense canopy opened only by small groups of selection fellings keeps the soil protected to the greatest possible extent to which *sal* regeneration obviously responds.

Advance growth

Advance growth, its tending and inducement will be dealt with here since it has intimate relationship with the manipulation of the canopy. As already mentioned natural regeneration of *sal* appears to depend almost entirely upon the presence of advance growth on the ground at the time of regeneration operations, and when such regeneration is absent, it is impossible to obtain it by any quicker methods. The procedure must be a search for the reason for its absence and the removal or counteraction of these adverse influences. In South Raipur, the adverse influence seems to be localised heavy grazing, but it is hoped that closure to grazing together with annual burning of leaf layer and soil loosening will result in regeneration. It is however anticipated that success will be very slow.[2]

Warren[29] strongly recommends that with regeneration everywhere in the whippy stage (in Singhbhum) it is not necessary to proceed cautiously by successive regeneration fellings. "We now proceed boldly leaving only six to eight stems per acre to act as mother trees and to stiffen up regeneration in places where it may be probably scanty." Owden [18] likewise recommends the retention of three to five standards per acre (but against clearfelling).

South Raipur experience is as follows. The canopy must not be opened so heavily that grass and weeds can establish themselves, or *sal* rgeneration will not appear. Where there is sufficient established regeneration the overwood may be completely removed. Where there is sufficient regeneration, but unestablished owing to a dense canopy and the forest floor is clean, the overwood is thinned lightly, the purpose of the thinning being to obtain just sufficient light to enable the unestablished regeneration to become established. Where regeneration is insufficient or absent owing to a dense canopy, and the forest floor is clean, again the overwood is thinned lightly the purpose of thinning this time being to develop crowns of the potential seedbearers, as in such areas it is considered that the first step towards natural regeneration is a supply of good seed. In this thinning the canopy is never opened so much as to admit grass and weeds; suppressed and dominated trees are not removed and trees of other species in *sal* areas are retained as far as possible as these are considered favourable to *sal* regeneration. Where regeneration is deficient or absent, the canopy medium dense or open and there is a heavy growth of grass, *all* the overwood is retained and it is considered such cases can be regenerated satisfactorily only by artificial methods. The mistake in the past has been the retention of any overwood whatsoever in areas of established regeneration and the opening of overwood too much in areas of unestablished or scanty

regeneration.[2] In Kolhan, Saranda, and Porahat experience tends to show that where regeneration already exists more satisfactory results are obtained if the first fellings are drastic, than the progressive opening of the canopy. [1]

Undergrowth

As already stated shrubs and underwood rarely cause difficulty; but grass may be detrimental. Makins [10] has given an account of the following undergrowth and their effect on *sal* regeneration. *Milletia* and climbers suppress *sal*. *Flemingia* appears to be a good nurse. *Clerodendron* (which however occurs in moister localities) is inimical. The grass *Imperata arundinacea* and *Heteropogon contortus* which come up in great profusion wherever a heavy opening is made, though generally considered a general nuisance, reveal on careful examination a large quantity of seedlings. Obviously the grasses must prevent a good deal of seeds from reaching the soil, but once it has done so, the grasses do not seem to offer any further obstruction. Hence Makins stresses the importance of burning the grass before the seedfall. Troup [28] mentions *Indigifera arborea* (in Singhbhum) and *Woodfordia floribunda* as indicator plants and possible nurses for *sal* regeneration.

Burning

Burning is unquestionably detrimental to *sal* regeneration in dry forests and there is ample evidence to bear this out. Troup records that in dry and moderately moist types the effect of fire protection on natural regeneration is generally beneficial and fire is one of the most serious obstacles to successful establishment of *sal*. Fire as a cause of unsoundness of trees in Sambalpur has already been alluded to. Experiments in Purnakot Range, Angul Division revealed (though the plots were not under proper observation, and hence there are no authentic records especially regarding *sal*) that in plots which were left to be naturally regenerated and in which nothing was done except to burn the undergrowth, there was no regeneration. Failure was probably due to the flames having risen too high and damaging the vitality of the seeds. [19] It is also believed that burning in March and April will damage the *sal* flower at that time. Effect of fire in Sambalpur forests also does not seem to be beneficial. [1] In Porahat Division experiments conducted in 1930—32 to discover whether burning and [1] or cutting back whippy advance growth improved the subsequent development of dry *sal* forest have shown that it appears definitely harmful to burn after cutting back whippy advance growth [26]. Meiklejohn [11] observes that the first thing that strikes one in the Bihar *sal* forests is the plentiful reproduction induced under fire protection. This is obviously due to the dryness of the climate and the consequent lightness of undergrowth and comparative absence of organic humus, both so prevalent in the wetter Duar forests. The Provincial Administration Reports[1] again record that early burning is not necessary for regenerating *sal* forests of the province (Bihar and Orissa) except perhaps in the extremely moist types. In other places it does more harm than good causing retrogression to a drier and more unhealthy type. "Water instead of fire is now experimented with." Again in Orissa, experiments in Angul indicate that in dry types of forests late burning is also harmful to the establishment of regeneration—a point that Warren has also stressed. Saranda experiments between 1925 and 1935 to test the effect of fire protection in dry and very dry *sal* forests show that fire protection encourages establishment whereas annual burning is harmful. [22]

In the Central Provinces, two plots in South Raipur Division (1920-22) were burnt after clearfelling. The result was a profuse growth of grass after the monsoon. The 1929-30 annual report however quotes Stein's experience that the clearfelling of the overwood followed by burning after working and cutting back where necessary, was completely successful in obtaining healthy young crop, provided however that fairly abundant growth was present before the operation was carried out. In Bilaspur, in the experience of English, *sal* seedlings shot up excellently as a result of successful fire protection. Old fire lines were grown with gregarious *sal* saplings and abundant young regeneration. [2]

Grazing Soil

Of grazing, much information is not available except that, as already mentioned, it is an adverse influence in South Raipur—responsible for scanty regeneration or its absence. Very little is likewise known on the manipulation of the soil before seedfall. Makins [10] has stressed

on the importance of wounding the soil before seedfall. Hoed up soil in the Purnakot experiments did not make any difference in the results (failure) of the experiments. Fire probably came into play. Nicholson[13] doubts if soil wounding to improve the state of regeneration will be of any use unless it is regularly carried out for several years, in which case it will be expensive. In this connection it is interesting to note that Troup[23] suggests the advisability of adopting the following two measures to preserve the soil moisture. One is to induce an underwood as soil protection, thus in time converting the forest into a moist type and thereafter treating it as such; and the other is to prevent the runoff of rainwater and encouraging its percolation into the soil by surface cultivation, trenching or surface embankment, this accompanied in the dry season by mulching if necessary.

NATURAL REGENERATION BY COPPICE.

Coppice *vs* Seedling

The very first question would be, which is the better form of regeneration—coppice or seedling. F. C. Osmaston's discussion of the subject has already been referred to. He concludes that from the point of view of timber there is nothing to choose between coppice and seedling tree. In Sambalpur there is no evidence to show that coppice will not produce sound full grown trees.[9] This is in confirmation of Nicholson's [13] earlier observation. There is also no evidence in Sambalpur to show how many times a *sal* tree will coppice. Although at present *sal* growing in poor dry soils coppices well, the strain of producing quick-growing shoots must be heavy. Little is likewise known as to how liable coppice *sal* is to become unsound, though it is probable that shoots from large stools are more disposed to unsoundness than those from smaller stools (say, under 8 inches diameter). In the case of large stools, the parent trees are likely to be hollow themselves and this character may be transmitted to their new shoots. [9]

One point that Osmaston [14], Nicholson [13] and Khan [9] have emphasised is that many of the existing *sal* forests have originated mainly from coppice on account of the habit of *sal* to die back, and also on account of the fact that many sal stands are on sites previously *jhumed*.

Miscellaneous

Coppice regeneration is usually excellent in Bihar and Orissa [9], [10]. In Sambalpur, stools up to 7 feet in girth are capable of producing good shoots, but the most vigorous shoots are usually produced from shoots of 4 feet and less. [13] Shoots from stools of two to six inches diameter are especially good and fast growing.[9] Troup [28] records a coppice shoot from Singhbhum from a stool of 9 feet in girth, but arising near the top. There is no evidence in Sambalpur to support the customary view that although coppice shoots grow very rapidly in youth, their rate of growth eventually slows down and that they are passed by poles of seed origin. Although the rate of growth of coppice shoots slows down markedly, it is always as fast, if not faster, than that of seedling poles. [13] Central Provinces also records vigorous coppice shoots of *sal* trees over 4 feet in girth, but these arose from the ground level. [2] The importance of retaining a suitable number of standards (seed bearers) to obtain regeneration to replace old and deficient stools is stressed by Bihar and Orissa. [1] The period of two to three years just after and during clearfelling of a coppice coupe gives excellent conditions for the germination of *sal* seeds falling from such mother trees and also enable partial establishment. The importance of cutting back whippy advance growth to produce vigorous coppice shoots has already been stressed on and small scale experiments conducted in Angul and Sambalpur confirm this.[1]

Burning

To study the effect of burning debris left in a *sal* coppice coupe after fellings, four experimental plots were laid out in Sambalpur. Though no conclusive results can be claimed, it would appear that burning results in an initial discouragement to the diameter and height growth of Q III *sal*, but this discouragement is more than overcome in later years. The popular belief that fire stimulates the growth of coppice shoots does not seem to be true.[1]

Height of cutting

Very little seems to be known of the effect of the height of cutting. Troup [23] however records that under dry conditions in Oudh, stems cut near the ground level produced better coppice shoots than those cut flush with the ground.

Standards

The effect of standards also does not seem to have been made a special study of and Owden's[18] reference to the importance of retaining standards has already been alluded to.

Root-suckers, pollards

Sal does not seem to be capable of reproducing by root-suckers. Regeneration by pollarding is however possible.[20]

Review

Before the section on Natural Regeneration is closed, it would be interesting to summarise the position with reference to Champion's 'Summary of investigations recommended'. The first requirement according to him, is a knowledge of the establishment period. This is not yet fully known. Troup suggests 50 years for Porahat and there is no reason why it should not be 100 years.

Information regarding burning is still incomplete. Champion has dealt with various phases of burning, *viz.* burning to provide a suitable seedbed, burning over recruitment, burning over unestablished regeneration, burning over established regeneration and controlled burning through regenerated coupes as a protective measure. Generally however burning would seem to be detrimental, in any phase to the regeneration of dry *sal*.

No soil studies seem to have been conducted for dry *sal*.

The advantage of getting partly established regeneration, in fact its being *sine qua non* for further operations has already been stressed.

The effect of grazing does not also seem to have been fully studied. The probability of its being an adverse factor in South Raipur has already been indicated. The question of rain-weeding is also yet to be studied.

Though climbers may be an adverse factor, they are probably not a very serious problem in dry *sal* forests, as is evident by the absence of any experimental data on the point.

Neither does any information seem to be available as regards bamboo competition, the cutting out of over-vigorous coppice shoots from mainly seedling stock regeneration and the period of working of regeneration coupes *vis-a-vis* the growth season of regeneration.

ARTIFICIAL REGENERATION

General

Artificial regeneration seems to be of subsidiary importance in *Dry Peninsular Sal*, probably on account of the fact that natural regeneration, though scanty, is adequate and the question of artificial regeneration arises only in cases where it is quite impossible to obtain natural regeneration. Accordingly artificial regeneration does not seem to be the practice anywhere. Champion [4] has "nothing to record" for Bihar and Orissa, and in C. P. Dry *Sal* "no work has been done." Central Provinces annual reports however say that efforts at artificially regenerating *sal* have ceased and in fact all attempts to obtain *sal* artificially in blanks and understocked forests have been comparative failures. Pit sowings, line sowings and seeds scattered over ploughed land have alike given germination, but the seedlings failed to maintain themselves till the next rains.[2] In Bihar and Orissa, though artificial regeneration is not being tried extensively, it has been tried on an experimental scale and some data, though scanty, are available.

Seed collection storage and treatment

The *Seed Weight Record* [23] gives the following information for Bihar and Orissa, based on sources available at the Forest Research Institute.

No. of seeds per lb. 350 (for C. P. 430).

Germinative capacity: 64 (200 seeds were tested. G. C. 22 from seeds of old trees, 37 from seeds of young trees and 44 from seeds of malformed trees.)

Commencement and completion of germination, in days after the date of sowing: 8 to 24.
Plant per cent: No information.

According to the *Nursery and Plantation Notes*, [15] the seeds ripen at the end of May or early June. Weight of seeds with wings 25 to the ounce; 14 fruits go to the ounce. The number of seedlings to be expected from a pound of fruits is 50. Seeds are to be collected during the middle of the period when they are falling, or two or three days after the time when the seeds begin to fall. The ground under a good seed-bearer should be swept clean and the seed that then falls should be collected.

According to Champion and Pant,[3] there was no difference between seeds of Bihar and Orissa (Singhbhum) origin and those of Central Provinces origin, as regards general appearance, seasonal history and susceptibility to drought. But frost killed back a number of seedlings from seeds of Singhbhum and Central Provinces origin, while seedlings from seeds of other localities survived the frost.

The summary of results from experimental plot No. 8, Angul Division, Orissa, formed in January 1925 and closed in January 1946, reveals the following information. The object of the experiment was to determine the quantity of seed produced in forests of good quality. The undergrowth was cleared annually and seeds were collected and counted. The average number of seeds per tree in two decades was 1145 *plus* or *minus* 232, the extreme figures being 3450 (1933) and 69 (1931) per tree. The average diameters of the trees were, 16.3 inches in 1925 and 18.7 inches in 1934.

Very poor seed years were, 1931, 1937 and 1941-44.

Poor seed years, 1925, 1928-30, 1932 and 1940.

Fair seed years, 1926, 1927, 1935 and 1936.

Good seed years, 1934 and 1939, and

Very good seed years, 1933 and 1938.

In a decade therefore there were, a very good seed year and a good seed year, the latter following the first and two fair seed years in succession. The classification was as follows:

Very poor seed years: Less than 500 seeds per tree.

Poor seed years: 501-1250 seeds per tree.

Fair seed years: 1251 to 2000 seeds per tree.

Good seed years: 2001 to 2750 seeds per tree.

Very good seed years: 2751 and over per tree.[27]

Ranchi seeds tested at the experimental garden at Hinoo (sown on June 30 and June 31) gave the following results.[24]

Nature of bed.	Germination per cent.	Remarks.
Flat bed with farm yard manure at 9 tons per acre.	20	Seeds from old trees over 5′ 6″ in girth.
Flat bed with farm yard manure at 9 tons per acre.	43	Seeds from crooked trees.
Flat bed with farm yard manure at 9 tons per acre.	36	Seeds from young trees 2′ 3″ in girth.
Raised bed.	72	Seeds from crooked trees.
Ploughed lines one foot deep and two feet broad.	24	Seeds from old trees.
Ploughed lines one foot deep and two feet broad.	45	Seeds from crooked trees.
Ploughed lines one foot deep and two feet broad.	38	Seeds from young trees.
Dug up lines in unploughed land.	66	Lines sown with *Tephrosia candida.*
Dug up lines in ploughed land.	49	Lines sown with *Tephrosia candida.*
Dug up lines in ploughed land.	30	Lines sown without *Tephrosia candida.*
Lines one foot deep and two feet bread.	34	Soil mixed with lime and ploughed.

It is useless to store seeds as their vitality may be lost within a week. They must be sown at once. If despatched to another place, they must be dried and despatched dry at once. No special treatment of the seed is necessary before sowing.[15]

There seems to be no information on nursery treatment for Dry *Sal.*

Plantations

There do not seem to be any big plantations of *sal* in Bihar and Orissa. In Nayagarh State (Orissa) however a plantation has been recorded and a peculiar circumstance regarding germination is worthy of note. The plantation was on an old *jhumed* land, very open and grassy, but with a scattered bushy

growth of dry deciduous species. Ten acres were thrice ploughed in the hot weather of 1913 and sown up profusely with *sal* seed broadcast. The existing open growth was not cut back in any way, but left to give some shelter and protection. On examination after the rains of that year, the results appeared poor and the operation was considered a failure. But in 1916, a profuse growth of *sal* up to four feet in height, none of them appearing fully established, was found. There was a dense growth of spear grass about three feet in height. No weeding was done, or other attention paid. In 1918 a fine crop of *sal* saplings, healthy and vigorous almost all fully established was found. One particularly fine stem measured 12 inches in girth and was by ocular estimate 20 feet high. The experiment repeated in 1916 and examined in Novemeber 1918 revealed a plentiful crop of young plants 6 inches to 2 feet 6 inches high coming up amidst dense spear grass about 4 feet high. The soil was sandy loam. No success was met with on poorer soils, particularly on soils rich on lime.[7]

Methods of stocking

Direct sowing seems to have generally met with success in Bihar and Orissa. In Saranda an experimental plot (No. 106) was laid out in fairly dry type forest. The area was clear-felled, burnt and *sal* seeds sown at the break of the monsoon in lines one foot wide, worked up one foot deep and spaced six feet apart. The area was fenced and kept regularly weeded. At the last annual weeding the grass and weeds were left lying on the lines as a mulch (important in dry localities). The summary of conclusions states that both the experiments may be regarded as success. The occasional gaps were due to attack by mice followed by white ants, which killed out even healthy *sal* plants with rootstocks of $\frac{3}{4}$ inches diameter and shoots 2-3 feet high. Weedings are necessary during the first three rains. Fencing against game or cattle is helpful and taungya work is recommended where possible.[25]

The *Nursery and Plantation Notes*[15] recommend that direct sowing is the only method of propagation that has been proved to succeed so far. The seed should be sown in hoed or ploughed lines one foot broad and 6 to 8 feet apart. In the lines two or even three rows of seeds should be sown, the seeds being about 3 inches apart in each row. It is best for these lines to be dug to a depth of 12 inches. The secret of success is weeding and soil aeration. Hence the lines must be kept weeded and the soil loose. If possible field crops such as *rahar* should be raised in between the lines and the land ploughed for two years in succession. The field crops should not be allowed to overtop the *sal* lines excessively. If this inter-cultivation of field crops can be managed, the extra aeration so earned is a very great help to the *sal*, which will not then die back. But even without inter-cultivation thorough weeding and hoeing along the *sal* lines will usually prevent dying back. *Sal* should be sown only on well drained soils where there is no grazing.

The Angul experiments already referred to under 'Natural Regeneration' included three plots where the under-growth was burnt, soil hoed up and seeds dibbled and broadcast. The germination was successful. Weedings were done half-heartedly in August, but still enough seedlings, healthy and strong, survived to give a fair crop.

Sowing *sal* with paddy in between the lines has also been tried. Mound sowings also have given fair success. Damage by rats seems to be an important feature. Drip (from a *pipal* tree) is another detrimental factor.[19] In Singhbhum, the advisability of sowing *sal* in cleared lines has been doubted as this makes the seedlings conspicuous to browsing game; if the lines are not cleared they escape the attention of game.[21]

No information is available about entire transplanting in *Dry Sal*.

Early tending

The importance of weedings and early tending has already been referred to when describing the experiments in the previous paragraphs. Thinnings will be discussed in a later section.

Cover and nurse crop

It has been recorded that the best results under forest conditions may be obtained by sowing *sal* seed with *Tephrosia candida* in dug up lines.[24]

Taungya

Taungya does not seem to have been tried on a large scale in *Dry Sal*. The experiments involving the sowing of field crops in between *sal* lines have already

been described. The *Nursery and Plantation Notes*[15] however recommend Taungya wherever possible.

Costs

The only records of costs available is in the Central Silviculturist's tour notes on the experimental plots near Kumdi, Saranda Division. He mentions Rs. 301- per acre for sowings including weedings.[6] There is no record of costs in the Angul experiments. In the Nayagarh State plantations already referred to, the extremely low figure of Rs. 1/8/- per acre has been given for ploughing and sowing (in 1913).[7]

No information is available on underplanting in Dry Sal.

Review

As in the case of Natural Regeneration, the position will now be reviewed with reference to Champions "Summary of Investigations Recommended".

Taungya is not extensively practised in Dry Peninsular Sal. No information seems to be available on the effect of climbers and the methods of dealing with them. Though *Tephrosia candida* has been suggested to be a cover crop, no details are available. Neither is any information available on grass growth and its effects, and the ways of dealing with it.

As regards replacing poor *sal* with other more useful species, Sambalpur working plan has suggested the raising of suitable species by the '*rab*' method. F. C. Osmaston has discussed the raising of *sabai* grass (*Eulaliopisis binata*) in poor quality *sal* forest of Singhbhum.[16]

Of plant indicators in *Dry Sal*, very little appears to be known.

TENDING

Before concluding a few remarks about the tending of the crop seem necessary, so far as it affects regeneration. The thinning of the mature crop, the manipulation of the canopy, etc., have already been discussed. Attention will therefore be paid only to tending in young crops. The importance of weeding in artificial work has been already duly emphasised.

Cleanings

Makins[10] has suggested that cleaning operations should be carried out at the end of the rains so that the coppicing of the undesired species may be discouraged.

The current working plan of Sambalpur[9] prescribes cleaning in P. B. I. by the end of June following the main felling. As a general rule the principal species (which of course include *sal*) are to be favoured against inferior species. Immature principal species of promising growth are to be retained as advance growth. A similar cleaning operation has been prescribed in the selection fellings of other periodic blocks. In the coppice coupes also cleanings should follow on the completion of the contractor's work (in March or June). Thinnings in the conversion forests will be done in the 11th year after the main fellings and in the coppice coupes at the age of 10 or 15 according to the rotation, which in Sambalpur is 60, 50, 40 or 26 depending upon the locality.

Thinnings

Warren[30] recommends mechanical thinnings in young crops for Singhbhum, the spacing being 7′× 7′ for II quality crop and 6 × 6′ for III quality crop at the age of 10 in P. B. I and P. B. IV (last P. B.), the cycle of thinnings being 10 years. The spacing in uneven-aged selection forests should be 'one-and-a-half times the diameter in inches, called feet'.

Climber cutting

According to the Annual Report for 1938-39, rain climber cutting had been adopted as a routine measure in P. B. I. areas of Bihar. Cleanings revealed that suppressed poles do not immediately respond to overhead light. They require cutting back to give them a new start.[1]

Mixture of species

Stein[2] deplores the tendency in South Raipur to carry out thinnings so as to create a pure *sal* forest by removing other species and suppressed trees have also thus been removed. It is advisable to retain trees of other species where they are not actually interfering with timber producing *sal* trees for the sake of conditions favourable to *sal* regeneration.[2] It is worthy of note that Troup [28] has also recommended a mixture and also an undergrowth of drought hardy species.

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WHAT'S IN A NAME ?

By Ellenbee

What's in a name, my masters? Why, everything, if our humble experience is to be taken as having any value.

There lies deep down within everyone of us a latent desire to be on nodding, if not on speaking terms with the scientific names of plants. It has some strange psychological basis—there is no getting away from it.

How often does one hear the following-"—So, you're a botanist. Too interesting. How nice it must be to know the names of all the plants".

You may aver with modest self-depreciation that you do not know the names of *all* the plants, but your denial only strengthens the impression that you do actually know them. Reputations like this are easy to acquire but not so easy to maintain.

You must be wary : pitfalls are many: danger lies ahead. All of us have experienced the circumambulation of the well-stocked garden with our host in charge. Listen respectfully to the stream of scientific names which roll off his tongue—with what unction does he give each syllable its full value—SCHIZANTHUS, DIMORPHOTHECA, PHACELIA, MESEMBRYANTHEMUM and all the rest of them.

This is what you hear if you are a complete ignoramus, and no harm is done, apart from a slight feeling of dizziness.

But if you are an expert and rival gardener the opening gambits are quite different, for gardeners engage in battle using the polysyllabic and polyglottal armoury of modern horticultural warfare.

The engagement in such a case usually starts with a discharge of light artillery such as the merits or demerits of—VIOLA, CALTHA, IRIS, GEUM, ADONIS and other genera which present no difficulty of articulation. As the contestants warm to their work one hears—FUMARIA, PELARGONIUM CORYDALIS, PORTULACA etc., rumbling and resounding like drum-fire in the distance. The battle

reaches its uneasy climax when V1s and V2s are brought to bear—ESHSCHOLTZIA, HOFFMANSEGGIA, LARDIZABALA, SINOFRANCHETIA, BLUMENBACKIA, GYMNOPETALUM. Happy is the warrior who has reserved for the knockout blow, some blockbuster rarity with an unpronounceable name.

We must confess that we have been worsted in more than one contest of this nature and have only escaped in an unworthy manner by remarking—"Anyway, I prefer bee-keeping".

We are, however, only biding our time, and hope in the not too distant future to gain a victory which will resound for all time.

We have, with infinite cunning, obtained the following plants from behind the "iron curtain":

ALLIUM BARSCZEWSKII.
EREMURUS SAPRJAGAJEVI.
GAGEA VEDENSKYI.
IRIS KUSHAKEWICZII.
ORCHIS SCHELKOVNIKOVII.

When the pain—for which we are totally unable to account—subsides from the region of the socket of the lower jaw—we confidently expect that the assimilation and subsequent discharge of this ammunition will pulverize our opposite number over the hedge.

Even your Indian gardener—the humble "mali"—can reel off the names of the flowers in his charge, though it takes some ingenuity and knowledge of philology to follow his variations on pronunciation. Calendula passes as "Calumdolla", "Saliva" for Salvia, "Keditamp" for Candytuft, "Spitunia" for Petunia, "Fullox" for Phlox—and a host of others.

Your "mali", discerning man, always seeks your advice upon the important question of the placing of the various plants in your annual beds. You, poor fish,—should your botanical knowledge extend to dividing all plants into (a) the daisy tribe and (b) the blue, red or yellow thingummybobs—just place them where their colours do not clash. All this is accomplished with much cogitation and shaking of heads. It really does not matter, of course, for the "mali" will also consult your lady, and she naturally alters the whole arrangement. This has no significance because the annuals are placed in exactly the same position as they have always occupied ever since your humble "mali" learned his job.

We, however, must place on record one moment of triumph which, even now, we recollect with feelings of satisfaction.

Our own "mali" asking us where the "Salivas" were to go, we answered—with speed of thought—"Beside the Spitunias of course".

Salvias may be scarlet, dash it, Petunias may be purple, but their close juxtaposition is in accordance with the principles of logic. Any other arrangement would be an offence to the orderly mind.

SHELTERBELTS IN SCOTTISH PLANNING *

By R. Maclagan Gorrie, D.Sc.

(G/2531/G.B—The various purposes for which shelterbelts are established in different countries are reviewed to point out that in every case forestry is being used as the handmaiden of agriculture. It is pleaded that forestry and farming should be complimentary.

***An historical review of the patterns of shelterabelts in Scotland from 1760 to* the present day precedes the discussion and the elaboration of the technique of the actual mechanics of shelterbelt planting and layout. The choice of species is discussed as also the planting of peat lands, and the value of shelterbelts is pointed out.)**

The Scottish Geographical Society has done me the honour of asking me to open this debate on shelterbelts, but I feel that there are many present who have a closer and more detailed local knowledge of the Scottish shelterbelt problem than I have. I should perhaps explain that my experience in this particular type of forestry has been gleaned from travel in a number of countries which have much greater extremes of climate than Scotland. In India we look upon shelterbelts as the best, and in fact the only, means of arresting the blowing of sand and the spread of desert conditions. In America, on the other hand, their great middle western shelterbelt project, begun in 1933, was modelled on earlier Russian

*Read at a discussion Group of the Royal Scottish Geographical Society on the 15th of April 1947.

experience in the southern steppes, and the main object was to temper the effects of parching winds in summer and drifting snow in winter, and so build up a more prosperous agriculture in areas of deficient moisture. In Ceylon belts of gum trees are being established both by government and by the tea planters in the steepest torrents beds and along the skyline of their highest mountain pastures as a protection against soil erosion. In West Africa the shelterbelt has been developed as strips of improved jungle left to conserve moisture between alternate belts of land cleared for cocoa. At the moment in East Africa shelterbelts are being planned to protect the latest Empire crop of groundnuts. You may at this point feel justified in demanding to know what all this has to do with Scotland. So, before leaving this general survey, let me point out that in every one of these instances forestry is being used as a handmaiden to agriculture and not as a separate profession. It is this aspect of the question which I wish to impress upon you as a Scottish audience, because I have been much struck with the narrow limits within which the forestry profession is working in this country. If forestry is more closely linked with farming, it will assume a more vital share in the reconditioning of our Scottish countryside, but I have been assured by the Forestry Commission men that if a sheep farmer wants a shelterbelt he should plant it himself because this is not "forestry".

Scotland's finest export is the men who have carried our high traditions and sterling character to the ends of the Earth, so in contributing to the rehabilitation of Scotland we must seek not merely to produce cattle, sheep and timber for Scotland's internal consumption, but ensure that she continues her function as the breeding place of men as well. Our aim then is to use scientific knowledge to the best advantage in making the fullest possible use of the land in order to provide a full, healthy, interesting and profitable life for the maximum number of people, whether they wish to emigrate or not. In reviewing shelterbelts therefore we must keep in mind that they are merely one aspect of the larger problem of proper land management.

Forestry and farming are both matters of husbandry and so should be complementary, not at loggerheads. It is only when the interests of one are exploited at the expense of the other on the somewhat narrow grounds of obtaining a maximum cash return from a single phase of work that it defeats the wider objective. Planting up of enormous blocks of hill grazing to secure the lowest production cost per cubic foot of timber has in some instances thrown sheep farming out of gear, and figures show that some 76,000 sheep have been displaced in the course of 20 years of the Forestry Commission's planting. If the function of shelter had at first been given the prominence it deserved, this displacement need not have occurred; this statement can I think be justified by making a brief summary of some historical facts from the ups and downs of rural welfare.

Many of the existing shelterbelts in Scotland were laid down between 1760 and 1850 in a roughly quadrilateral pattern to correspond with the then new ideas in improvement of layouts and communications, as has been described by Dr. Lebon in *Scot. Geog. Mag.* for December 1946. The war-time feeling of many of these old woods has exposed the farmland to an extent which has only been realised during the recent severe cold spell. Andrew Wight in 1778 in his *Present State of Husbandry in Scotland* advocated the planting of strips and clumps of trees in mixture, using Scots pine as a nurse for broadleaf species, and for these he advised much care in selecting strong well grown plants and ball planting. Much good work must have been done on these lines in the late 18th century, when every farmer did his own tree planting. In our own times this mantle seems to have fallen on the larger land-owners rather than on the farmers. Sir Hugh Shaw Stewart of Ardgowan, to quote only one example, made some shelterbelts about 1910 on the open Duchal Moor at 700 feet, and the sheep farmers so appreciated the value of this shelter that they gladly surrendered grazing ground to be planted. For the higher hills Lord Lovat and Sir John Stirling Maxwell in their *Forest Survey of Glenmor* in 1911 advocated that for completely deteriorated sheep land the whole of one farm at a time should be planted up before attempting any other, but that for average good sheep ground in the zone of 1,000 to 1,500 feet, one-third only should be planted, and the remaining two-thirds would improve in productiveness as a result. Subsequent surveys have confirmed that in much of the wetter western highlands sheep farming has deteriorated so

seriously as to justify planting on a large scale. Between 1871 and 1942 there has been a 25 per cent reduction in the head of sheep in the five counties of Argyll, Inverness, Ross and Cromarty, Sutherland and Perth, though the total for the rest of Scotland has increased by 27 per cent.

To indicate the parts of Scotland for which I advocate an intensive survey for the choice of plantable sites for shelterbelts, the land utilization survey sheet giving the types of farming in Scotland should be compared with the distribution of existing woodlands, including both the Forestry Commission's woodlands and the more dispersed private holdings of woodland which include widely spaced shelter-belts and amenity timber such as parks and policies. The chief limiting factor in the growing of trees in Scotland is the height above sea level, so we can consider all land below the 1,500 foot contour, as this is commonly accepted as the upper limit for tree growth throughout most of the country.

A comparison of these data gives a fair idea of planting potentialities. We must omit the main central highland block as being too high, but apart from this, almost every country has appreciable areas of land below 1,500 feet. Caithness and coastal Aberdeenshire in the north and the whole of the borders in the south offer the largest areas of farmland still devoid of any appreciable shelterbelt planting. Other indications are Sir Frank Mears' plan for central and south-east Scotland which refers specifically to the need for shelterbelts in the reconditioning of the Slamannan plateau south of Falkirk. Prof. Alan Ogilvie in the *Scot. Geog. Mag.* of September 1934 has mapped the areas of gentle slope and therefore of bad drainage, between 400 and 1,100 feet elevation and has recommended afforestation for them. In addition to the Slamannan plateau he thus includes considerable areas in west Fife, the Lothians, Lanarkshire and Berwickshire. As regards the upper limit of planting, natural Scots pine and birch in Rothiemurchus run up to about 2,000 feet. An example of sucessful planting above the arbitrarily chosen 1,500 foot level is seen in larch at 1,900 feet at Dunkeld. The upper limit of tree growth in the Alps is about 2,000 feet and in the Himalayas is higher still, whereas on some our more exposed sea coast it is practically at sea level. The choice of 1,500 feet as an upper limit is very arbitrary and not to be strictly applied.

The chief stumbling block for private planting has of course always been the expense, but two recent pieces of legislation should simplify the problem of finance. These are the dedication of woodland and the hill sheep farming acts. Under each of them a considerable share of the first cost of planting can be met by government. So far there has been no indication that under its dedication scheme the Forestry Commission is prepared to undertake anything but commercially justifiable planting, but many belts with a quarter-mile width could be so justified and at the same time provide much needed shelter for livestock. Where this dual purpose cannot be proved, than a 50 per cent share of all improvement costs can be claimed under the Hill Sheep Farming Act. For lots of less than 50 acres this would in any case be the better of the two, because the dedication scheme as promulgated does not cater for small woods.

Now we come to the actual mechanics of shelterbelt planting, and in this, foreign experience should be of some value. In terms of density of planting there are three main types :—

(*i*) Impenetrable to wind throughout the height of the trees.

(*ii*) Slightly penetrable below, impenetrable above.

(*iii*) Fully penetrable throughout their height.

Densely planted coniferous plantations are of the first type until they reach an advanced age and open out when casualties occur or thinnings or selective fellings are made, but they can be modified by underplanting, which actually establishes a fourth type. Broadleaf species open out much more quickly and many of the old beech belts are so wide spaced as to provide indifferent shelter as a belt, although individual old beech in themselves give fair amount of shelter to livestock. The question of underplanting with shade-bearing trees or shrubs to form a lower storey should be kept in view as a means of improving old open belts rather than scrapping them entirely and starting afresh.

The Russians favour the penetrable type as the best means of preventing snow drifts. The typical American belt of 3 to 5 rows of a main species with two or three rows of a subsidiary as a second storey generally opens out after a

few years. Under Scottish conditions the wind itself is the chief trouble for livestock, rather than the formation of snow drifts, so impenetrable belts are probably the most profitable. The Russian findings on the prevention of snow drifts, and the width of ground which is protected by trees of a given height, are for steppe conditions, so are not directly applicable to our Scottish uplands and we should be chary in applying their figure for optimum spacing, which is reported to be 1,000 yards between belts only 50 feet wide.

In planning the layout of a belt, three different types of protection are required, namely: (*i*) for buildings; (*ii*) for arable land; and (*iii*) for hill pasture land. For all three you require to know the local winds and to plan to frustrate them. For buildings, do not plant too close to the building, but keep the trees 1¼ times their final height away from the actual building. The belt need not be more than 60 to 100 feet wide, but a dog's leg shape facing two wind directions is very effective. Where the house is right on a hilltop, a single or double row of trees close against the house is useful. Data from the U. S. A. show that farm shelterbelts can reduce the household fuel bill by 40 per cent, and in view of the painful experiences which most of us have had this winter owing to lack of household fuel, this aspect of shelterbelt protection deserves more notice than it has so far received in Britain.

In the flatter arable lands, farmers are naturally loath to give up plough land, so belts can, if necessary, be restricted to the American type of a few rows of trees, but 100 to 150 feet width will ensure the production of reasonably clean poles, and belts can often combine the functions of roadside avenues and shelter. In the steeper hills and higher plateaux, the chief wind is generally down-valley, so cross ridges running down into the main valley are important, but planting right on a stony ridge is often unprofitable, so planting in the lea of the ridge is better, or even in the lea of a dry stone dyke. Local downhill blasts from higher ground may justify alignment along the contour. For such ground a width of 300 feet is the least that will supply satisfactory clean poles for fencing, and also allow the gradual replacement of the belt at maturity without clearfelling and loss of the gradually built-up wind resistance. American experience in areas of bad snow and wind has recently been summarised by Bates and Stoeckeler in the March 1946 *Journal of Forestry*. Most of their 160-acre farms in the Middle West now have at least one belt right across at right angles to the worst wind, while orchards have enclosures of from 3 to 20 acres between belts. In 1934, when I had the privilege of seeing this work in its infancy, the project was meeting with a great deal of opposition from the Middle West farmers, but now those same farmers tend their own belts, and the percentage of failure has been astonishingly low considering the climatic extremes of winter frost and snow, and summer drought and scorching wind. Under such conditions the secret of success lies in persistent inter-cultivation by hoeing and soil working between the rows of young trees until they have formed a complete canopy, but this should not be necessary in the moister conditions of Scotland, where inter-cultivation is needed only until the weed growth has been mastered. Experience abroad points to the need for rigourous exclusion of all animals during the formative period. In Scotland fencing against rabbits is in any case essential, and in many cases the heavy expense of a deer-proof fence will also have to be faced. Farm animals must be kept out until individual trees are out of danger, and the amount of grazing which can subsequently be allowed will have to be determined locally.

As regards choice of species,—Scots pine, Norway spruce and beech should be used as much as possible where shelter only is the objective. But where posts and poles are wanted from thinnings, Sitka spruce or Japanese larch are more likely to produce a good cash return. Although Sitka spruce is generally the most profitable in giving early returns of cash, it should not be planted pure in large blocks where frost damage is likely as it has proved very frost tender. On chalk and limestone the Austrian pine is useful, and for high elevations mountain pine and lodgepole pine are good. For moist grassland, Norway or Sitka spruce; and for dry grassland, Scots pine or Jap larch; in heavy bracken areas Douglas fir, both the Jap and the European larches, Corsican pine and *Thuja plicata* are good; and for frost hollows hybrid larch and lodgepole pine.

The planting of shrubs and broad-leaf trees as an understorey and around the outer edge should include rhodendron, snowberry, dogwood, hawthorn, Lowson cypress, rowoan and sycamore as well as beech. Gorse and whin

also make good nurses, and so also does the native birch.

The planting of peat lands is a special study in itself. Norway and Sitka spruces are usually advised for reasonably good peat, and for Calluna moorland with thin peat, Scots pine or Jap or European larch. In the *Scottish Forestry Journal* for 1931, Dr. Marcel Hardy advocated for the Outer Hebrides, Sitka spruce, Jap larch and *Thuja*, with mountain pine or birch on the windward fringe. Early attempts at planting peat bogs were restricted to mound planting upon upturned curves of peat, but since the appearance of heavy tractor, the use of a heavy mould-board plough to dig drains and throw up plantable ridges has become popular and is much more effective.

If the present proposals are carried out, a very large percentage of shelterbelts will have to be established on peat, and so I should therefore like to say a further word about peat reclamation. It is frequently brought forward by farmers as a challenge that foresters have so far failed to make any use of peat areas which are useless for any other purpose. It is true that research results have so far been disappointing and we have to admit that on the poorer cotton grass *Scirpus* peat the prospect of commercial planting is poor. On the other hand there is a reviving interest in the utilization of peat as a raw material for a variety of uses which have been admirably summarised by Clement and Robertson in Bulletin No. 16 of the Scottish Reconstruction Committee. Any regional development of peat, either by distillation or by using it as a fuel for factories or gas plants, should be followed up very closely by foresters, because the fresh level of the peat bog after such working may be feasible for planting. Also the chemical or bacterial treatment of peat may lead to its use for composts and mulches. Excellent briquettes can be made from a mixture of puddled coaldust, sawdust and shredded peat, and I cannot think why in this present fuel shortage the ministry of fuel and power does not encourage the manufacture of briquettes from these waste products.

The utilization of peat forms part of a larger problem, namely that of repopulating and revivifying the dwindling rural communities of our Scottish countryside. There is no use planting shelterbelts if there are to be no farms or livestock left to shelter. To make the best use of hill land we need combined operations, for it is now abundantly clear that we need to use heavy machinery to reclaim it, and a permanent herd of cattle to prevent it from going back subsequently to acid conditions. Many successful plantations have been made by tractor ploughing by the forestry commission, and a somewhat similar technique has produced improved grasslands at Aberystwyth by scarifying the peat and heather in order to sow improved grass strains, thus showing that the common hill grazing can be made much more productive. Further it has been shown by Mr. Grant at Knockie and on the Glentannar estate that a more intensive utilization by cattle as well as sheep is also essential. The logical outcome of these demonstrations has been that government recognized the need for keeping more cattle and has tried to encourage this by means of its hill cattle subsidy. Under this in 1944, applications affecting over 100,000 cattle cost government £340,000. But these cattle were only seasonal, whereas Mr. Duncan Stewart of Glenlochay insists that permanent improvement can only be brought about by an all-the-year-round use of cattle, and only after the hill grazing has been treated intensively with tractor ploughing to ensure proper drainage and seeding with improved grasses.

We thus have at our disposal three means of ensuring a better utilization of down-at-heel hill grazing land, namely the afforestation of only a fraction of it preferably in shelterbelts, a forceful attack with machinery to establish a better balance of summer and winter forage and a guarantee of continuity through the judicious use of cattle as well as sheep. I feel that if this triple approach were given a fair trial, the present suspicions of the sheep farmers towards any kind of afforestation would gradually be overcome, and the areas to be selected for planting could be chosen by agreement on the spot, and with the help of the local shepherd's unrivalled knowledge of wind and weather.

The value of the shelterbelt as an amenity in places patronised by summer visitors and tourists should also be remembered, but plantations in much frequented areas are disliked by foresters because they are specially vulnerable to fire. Precautions have therefore to be taken and fire fighting organised on a sound basis at the beginning of each summer

season. It is only through education that the public can be made conscious of their responsibility, and the extension of the cult of national parks is a welcome step in this direction, but needs to be implemented by something in the nature of a parks service of rangers who can lecture and demonstrate as well as do the fire fighting.

FARM FORESTRY IN INDIA

By A. P. F. Hamilton, C.I.E., O.B.E., M.C., I.F.S.

Inspector-General of Forests to the Government of India

G/341/In., G/114/In.—Forest Policy in India, though sound in principle, has been applied over a comparatively limited area; it has not been able to secure for agriculture the benefits and the protection which the industry should expect from forestry and as a result the plight of the farmer is serious over wide areas. The situation now demands that forestry must be linked far more closely with agriculture.

The difficulties in establishing farm forestry will be mainly in the field of application though research in technique and species is necessary, particularly for shelter-belts and wind-breaks.

Farm forestry-schemes must be closely integrated with general plans aimed at making the countryside self-sufficient; for this purpose a special administrative and executive organisation is advocated.

Considerable experience in farm forestry has already been gained and the lines of development proposed are largely based on it.

Legislation is required for forest protection and to provide sanctions in the last resort. In several administrations legislation has either been enacted or is under consideration.

A POLICY FOR FARM FORESTRY.

In their pronunciation of forest policy in 1894, the Government of India underlined two important principles; first, the necessity for securing sufficient forest for the general well-being of the country and second, that the preservation of the climatic and physical conditions of the country came before anything else. During the past half-century various influences have caused an extension of agriculture over vast tracts of land with but little considerations for the foregoing principles. The development of agriculture has been on extensive rather than intensive lines and without due regard to the primary needs of the

industry; as a result an ill-balanced rural economy, with its attendant evils of erosion, reduced soil moisture content, shortage of fuel, timber and grazing, has developed over these areas.

The distribution and extent of India's forest reserves is far from satisfactory from the point of view of the 1894 policy; to a limited extent only can the State forests meet the requirements of the agricultural community and afford protection against unfavourable climatic influences, both of which are essential to the establishment of permanent and prosperous agriculture. In a country like India where a capricious rainfall and the prevalence of much marginal land only too often reduce agriculture to the level of precarious subsistence farming, these essentials are of increasing importance. Agriculture in India is in dire need of the assistance of forestry; the extension of State forests may improve matters locally, but the real solution is to bring forestry on the farm; in other words, those same two principles of forest policy must be given a far wider application and must be extended to the whole countryside. And in the fullness of time the farmer himself must be the agent for giving effect to this policy.

THE TASK

The term "farm forestry" conjures up visions of well-timbered, self-sufficient agricultural lands with every farmer his own forester; and though this may be a possible, however distant, goal in some parts of the country, there are practical difficulties which will compel the use of expediencies not seen in normal forest practice.

In short, the general objects of farm forestry in India are :—

(*a*) to achieve the maximum degree of self-sufficiency as possible on the farm;

(*b*) to utilise the land to the best advantage;

(*c*) to increase the fertility of agricultural lands by preventing erosion and increasing water storage in the soil, by mitigating the desiccating effect of hot winds, by providing firewood in place of the cow-dung at present almost universally used as fuel;

(*d*) to improve the condition of cattle by introducing pasture management and stall-feeding and by providing leaf fodder to supplement the chronic fodder shortage;

(*e*) to supplement, where possible, the farmer's income.

Farm forestry has to be adapted to meet a great variety of conditions. There are the great estates in the north-west, arid, treeless and wind-swept where the tradition of cattle-herding is strong and the landlords often apathetic; the "desert fringe" of Sind and Rajputana with its menace of shifting sands; the intensively cultivated tract of the Indo-Gangetic plain where holdings are often small and fragmentary; the ravine lands skirting many rivers and ranges; the vast tract of the Deccan uplands, constantly under the shadow of famine; and finally the heavily cultivated rice lands of the south.

Though the remedies may often be obvious, their application is the real problem. It is difficult to convince an uneducated peasantry, often lacking in imagination, that by changing his method he can escape from the conditions which he and his forefathers have come to accept as inevitable.

Systems of land tenure and tenancy vary greatly, requiring different approaches to the same problem; until there is a clear understanding on both sides of the meaning and intentions of Government policy, attempts to establish farm forestry may sharpen the conflict between the interests of landlord and tenant. Indiscriminate and excessive grazing and browsing, due partly to religious prejudice and partly to a vicious circle set up by misuse of the land itself, is one of the greatest difficulties, the final solution of which must rest with the people themselves.

Finally there is the question of finance; the country is poor, and the resources of the State are not unlimited. The establishment of a balanced farm economy will require the sinking of considerable capital in the land; both the State and the farmer will contribute towards this, but outlay in terms of money and effort must, to some extent, be related to the capacity of the land to respond to a given technique and, in the long run, to repay the capital and effort. But any tendency to take too parochial a view of the financial aspect would be a mistake for, as

has already been explained, farm forestry is an extension of an intrinsically sound all-India forest policy and is itself a nation-building movement.

GOVERNMENT'S ROLE. ORGANISATION. STAFF.

Schemes for the development of farm forestry must be closely integrated with general planning for the improvement of the countryside and this means that the activities of a number of departments, Agriculture, Forestry, Animal Husbandry, Revenue and Co-operative must be closely co-ordinated. Rural development is not new in India, but the departments have worked apart, co-ordination has been wanting, and experience has shown that the ordinary departmental machinery, even though it may be co-ordinated at ministerial level, is unable adequately to cope with plans which involve the multiple use of the land. A vast field has to be covered and the only practical policy seems to be the formation of a single organisation which will ensure both continuity of policy and the co-ordination of experience and effort. Such an organisation, either a separate Department, or a Board suitably represented at the corresponding administrative levels, would, to begin with, be manned with experts drawn from the departments, but might later recruit and train its own staff. This policy is strongly advocated by Provincial Forest Departments and it is hoped that local Governments will accept it. It is hardly necessary to emphasise the need for securing the co-operation of the public by encouraging the formation of local non-official bodies.

In the meantime, however, considerable progress has been made and everywhere the Forest Department has taken the lead. Pending the formation of a composite organisation, the tendency is to expand the department on a territorial rather than a functional basis, though there is some disagreement on this point. The ultimate object is to have in every district a forest officer who will be responsible for all land development activities on the forest side, including pasture management, soil conservation, shelter-belts, firewood reserves, etc. The subsequent formation of a separate department would not be seriously prejudiced by departmental expansion on these lines.

Farm forestry and all that it implies is daily bringing the Forest Department into closer contact with the rural population, but it is recognised that there must be a closer link with the village and with the farmer than the ordinary departmental staff, with its highly technical training, can provide. Something of the nature of an "extension service" is required, and one Province has already set up a school which provides free training in the elements of forestry and soil conservation to men drawn from the cultivating classes.

A corollary to this section is that the officers of each department should know something about the work of the others and instruction to this end should begin at the training institutions.

FARM FORESTRY IN PRACTICE.

There are numerous examples to show that in the better developed parts of the country the farmer at one time appreciated the necessity for conserving his land and supplying his own requirements. His efforts to do so have often failed owing to lack of technical knowledge, and often the good work of a prudent father has been undone by an improvident son. The value of closure to grazing and the training of torrents is not unknown, particularly in the north-west. Shelter-belts have been planted but usually for the protection of orchards; in arid, wind-blown tracts the relics of hedges or low wind-breaks are a not uncommon sight and the growing of trees on the boundaries of fields or round wells is a feature of some parts of the country; the value of the lopping of certain trees for fodder and green manure is understood, though it may be practised in a destructive and wasteful manner. Of recent years the growing of firewood plantations of *Casuarina equisetifolia* in the eastern coastal belt has become popular and very high prices have been obtained by the owners.

In the Punjab soil conservation measures undertaken by Government have demonstrated the value of farm forestry and the demand for assistance by individual farmers and village communities for the formation of plantations on their lands is increasing. Thousands of acres of *Dalbergia sissoo*, one of the most valuable trees in India, have thus been established on private lands and many are already managed under working plans or

schemes with the active co-operation of the owners.

Local conditions necessitate wide variations in the methods of approaching problems, in technique and choice of species and this latter will require the closest attention in view of the widely differing objects of management. In general, farm forestry is being planned on the following lines :—

(*i*) The proper management of privately-owned forest under working plans will be enforced by legislation.

(*ii*) The owners of large agricultural estates will be encouraged to retain a small area, say, 5 per cent. of the land under tree crops, and to afforest waste land ; Government may be vested with residual powers of compulsion.

(*iii*) Where there is a well-organised village community, the common land, or neighbouring crown waste, if there is any, will be managed as village forest by co-operative societies or village committees under working schemes.

(*iv*) Farm forestry will be closely integrated with major or minor soil conservation and land development plans ; and the opportunity for laying the foundations of a well-balanced economy *ab initio* will be seized wherever large-scale colonisation schemes are undertaken.

(*v*) In the intensively cultivated tracts with small, often fragmentary holdings, farm forestry in the real sense is not possible. These areas are, however, critically short of forest produce. The peasants will be encouraged to grow deep-rooted and valuable trees such as *Acacia arabica* on field boundaries, round wells, etc., and on small areas of uncultivable land. Starting with two or three trees per acre, the cultivator, when he realises the advantages, will himself work out the optimum number of trees that he can grow round his fields. The consolidation of holdings has greatly assisted farm forestry.

(*vi*) Hot drying winds, particularly those which blow at the end of the winter and monsoon rains when the grain is beginning to swell, seriously reduce crop yields. Shelter-belts on the American and Russian scale may be impracticable in India, but Government must be responsible for what primary system is possible, and this will mainly take the shape of canal and roadside avenues and the margins of rivers. For the rest, the measures described above will do much to provide a system of interrupted shelter-belts. Research, undertaken jointly by the Agriculture and Forest Departments, to establish the most suitable species and technique for shelter-belts and wind-breaks is important.

(*vii*) Grazing and fodder requirements are given prominence in land planning.

(*viii*) Farm forestry will be made to pay where possible. The production of many valuable minor forest products, such as tanstuffs, fibres, lac, gums, grasses, can be developed, and local industries will be encouraged.

(*ix*) Financial assistance is often necessary; policy varies, but loans on easy terms are made to larger farmers and landlords ; subsidies are given to impecunious cultivators on certain conditions.

(*x*) An organisation for publicity and education is essential.

(*xi*) The basis of land planning must be a survey of a règion, conveniently a civil district, which will provide a blue print of economic development. A survey might indicate the necessity for establishing State firewood reserves to prevent the denudation of the countryside by the demands of some local consuming centre or industry.

LEGISLATION.

Legislation is necessary for two purposes, firstly, as in the case of State forests, to provide protection for private and community forests,

particularly in localities where respect for property leaves something to be desired. There is such provision in the Indian Forest Act, and it is being used.

Secondly, legislation of a compulsory nature is necessary to give effect to the principle of the greatest good of the greatest number; the progress of plans must not be obstructed by a recalcitrant minority. Legislation in this sense has already been enacted in India in the interests of soil conservation and experience has shown that if it is used wisely and is backed by a sound policy, resentment which may have been shown to begin with soon dies down, and is followed by willing co-operation.

The degree of State interference will naturally vary, and it can be assumed that for a long time the management of farm forests will have to be closely supervised by Government. But it must always be the primary duty of those entrusted with the furtherance of the movement to train the landlord or farmer to manage his own land, and to inculcate a spirit of self-help.

THORNY SHRUBS—A BLESSING IN DISGUISE

M. D. CHATURVEDI, B.SC. (OXON.), I. F. S.

Chief Conservator of Forests, U. P., Naini Tal.

S/430/U.P. S/632/U.P. S/6332/U.P. G/283/U.P. G/12130/U.P.—Basket transplants of "nim (Azadirachta indica)", put out at the break of rains, in pits 18″ deep and across, inside dense thorny shrubs, have succeeded in Fisher Forest (Etawah) and Kalpi where "babul" raised at considerable expense was strangled to death by the impenetrable pan of calcareous nodules ("kankar") occurring at depths varying from 4 to 8 feet. "Nim" is an amazingly thrifty species and reaches fairly large dimensions in soils no deeper than about 6 feet overlying "kankar." About 25 standards to an acre established in this manner provide an attractive solution of the problem of afforestation of ravine lands. "Nim" regenerates itself and there are no subsequent formation costs.

In the *Yamuna* ravines, where intercalated pans of calcareous nodules (*kankar*) frustrated all ambitious attempts at raising *babul* (*Acacia arabica*) plantations, we have marked time for the past 15 years. *Babul* raised at considerable expense, was literally strangled to death by the *kankar* pan. We have done nothing since, except regulating grazing and looking after tree-growth which survived over alluvium in valley bottoms.

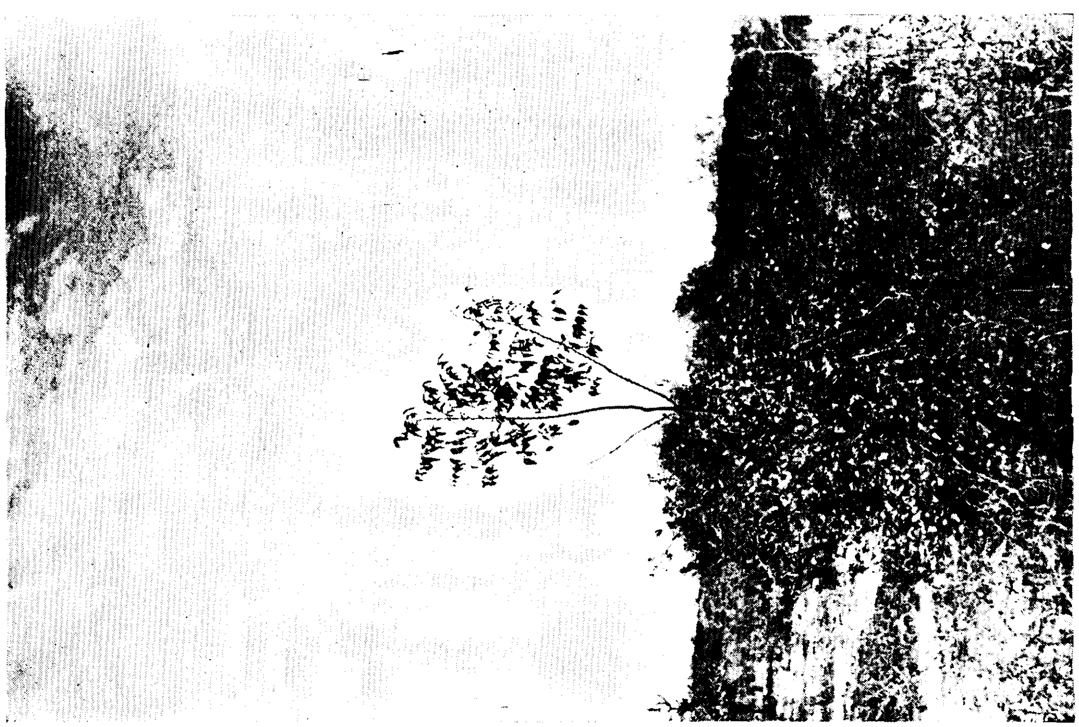
The creation of the Land Management Circle in 1945 in the United Provinces, once again riveted attention to the exploration of the possibilities of the utilisation of wastelands, where underlying pans of *kankar* defeated us in the past. The new technique which has been developed during the last 3 years at the Fisher Forest, Etawah, is described here to enable trials in similar localities elsewhere.

In the Fisher Forest, the top layer of loamy clay overlying *kankar* pan, varies from 4 to 8 feet in depth. The sub-soil is bone dry. Among the various species tried, the only valuable species which has been found to survive under such exacting conditions (rainfall 28 inches, erratic) is *nim* (*Azadirachta indica*). It is an amazingly thrifty species, being content to shift for itself in the limited layer of soil overlying the *kankar* pan. The tree reaches fairly large dimensions in soils no deeper than about 6 feet.

Despite the bitter taste of its leaves, *developed presumably as a protective device, the* tree is sought by every single animal associate. Camels, goats, cattle, porcupines and hares, all go for it. Even human beings have declared it to be a medicinal plant. Afraid of its numerous enemies, the young seedling hides itself in the innermost recesses of thorny shrubs, where it continues a desperate fight for existence. After a good many years of hard struggle, it emerges triumphantly from the thorny shrubs which act as its veritable nurse. Once above the reach of cattle, it continues its career unmolested and soon grows into a tree.

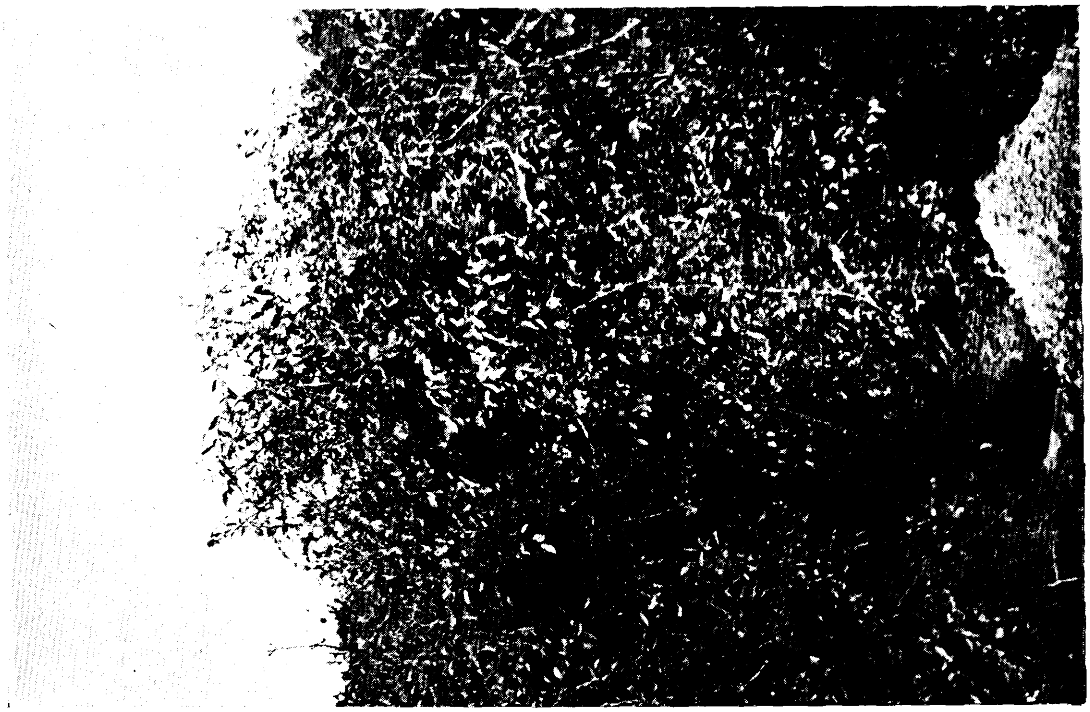
The horrid thorny shrubs *hins* (*Capparis horrida*) *Karil* (*Capparis aphylla*) and *hingot* (*Balainitis roxburghii*) have proved a blessing in disguise. These shrubs act as a veritable haven for *nim* and play a vital role in the raising of *nim* in localities which can support little else of value.

Fig I



Nim, triumphant and deficient.

Fig. II



A pit inside dense shrub growth.

To assist in the fight, which *nim* has to put up, the procedure evolved at the Fisher Forest (Etawah) and Kalpi by Mr. J.R. Singha, I. F. S., consists of :—

(1) During the cold weather, when the soil is soft after winter rains, pits are made 1½′ across and 1½′ deep, with soil heaped aside to weather. The pits are located deep inside dense shrub-growth which is left intact, as far as possible, except what must be cut to get inside the hedge for digging the pit.

(2) Such shrubs are usually available at an average distance of about 10 to 15 feet apart in these localities, giving about 20 to 25 pits per acre.

(3) *Nim* sown in July gives excellent seedlings for transplants by February, the following year. *Nim* transplants are put out in baskets in February, *i.e.*, before the sap is up and nursed throughout the summer in baskets. They have to be shaded against *loo*. They need protection against browsing even in nurseries!

(4) These basket plants are put out in the forest in July when the monsoon has set in well. The entrance to the pit is blocked by *hins* or other thorns and the plant left to grow. The plant is secured full overhead light, by beating up over hanging branches with a stick.

(5) Thorns placed at the entrance must be constantly watched against damage from cattle or goats and replaced, when necessary. The plant should be kept free from being suppressed by the shrubs which should be beaten into ship-shape form to give clear overhead light to the seedling inside.

(6) *Nim* is frost tender. Shrubs in addition to warding off browsers, provide protection also against frost. They also stand in good stead during hot weather when the desiccating *loo* plays havoc with vegetable kingdom.

(7) No weeding or cleaning is needed except one hoeing in October and one in March, to protect young plants from frost and *loo*.

(8) The cost per plant established seldom exceeds a rupee a basket plant.

Once, about 20 to 25 *nim* trees have been established in an acre, the task of afforestation is accomplished for good. These standards will provide sufficient seed to regenerate the area naturally under the protection of thorny shrubs. When the old standards have been felled, younger trees will take their place. The establishment of seedlings under natural conditions will take its own time, the length of which need not detain us. The least little assistance to young seedlings struggling in shrubs will shorten the regeneration period considerably.

In these localities, it is proposed to develop rotational lopping for goats, *i.e.*, letting *nim* trees be lopped once in 4 years. A rest of 3 consecutive growing seasons helps trees recoup from damage due to lopping. The wretched goat—an anathema to forest officers—is the poor man's cow and the rich man's meat. It must be provided for, in any plan of rural economy and land management.

Although, not so valuable as *sissoo* (*Dalbergia sissoo*) or *babul*, *nim* timber finds a ready market for door and window frames, planks and scantlings, agricultural implements and household furniture. Its bark, gum, leaves and flowers are utilised in indigenous medicines. The seed yields a valuable oil. It might be emphasized that *nim* is the most useful species which can be grown on dry shallow soils overlying calcareous deposits. There is precious little moisture in the sub-soil and experience gained during the last 30 years in the afforestation division suggests that nothing else would grow under the rigorous conditions which obtain in the *Yamuna* ravines.

CASTELLIA TUBERCULOSA (MORIS) BOR IN INDIA

By N. L. Bor.

G/47/Pj., S/O/Pj.—The discovery of the grass Castellia tuberculosa in the Punjab makes an extraordinary case, as it has never before been found east of Greece, and the present place of its discovery is some 800 miles from a port. To aid identification, a plate and description are given, in the hope that the species will be rediscovered in India. The correct taxonomic position of the species has also been stated.

The discovery of the grass *Castellia tuberculosa* (Moris) Bor near Campbellpur in the Punjab is yet another of those striking cases of discontinuous distribution which crop up every now and then. What makes this particular case so extraordinary is that this grass has never been found east of Greece and its occurrence, not near a port but well inside India, raises the question of its status in this country. The distribution of the grass, so far known, is West Mediterranean and it is fairly common on both shores of the Mediterranean and on the islands from the Canaries to Greece. Exotics are usually picked up near the ports where the seed arrives in ballast or lodges in crevices in cases of goods but it is uncommon to find exotic plants for the first time nearly eight hundred miles from a port. At the same time it must be remembered that the *Gramineae* have been somewhat neglected by Indian botanists and it is posssible that this species has been overlooked up to the present time. If it is really indigenous it should be possible to collect it again and settle the point. The specimen collected was in full seed and so far as is known there is no reason why it should not have reproduced itself. If this grass is found to be indigenous we are faced with far more difficult task of explaining the immense gap between the Punjab and Greece where it does not occur. Apart from Afghanistan the grass flora of the countries from Iraq to Greece is well known and it can be taken as probable that the grass does not exist in these places. At the present stage explanations can only be speculative, but is it not possible, always assuming that the grass is indigenous, that it is a survivor, a vestige as it were, of the days when Thetis stretched from Assam to the Caspian ?

This note has been written in the hope that some keen Indian botanist will try and discover this grass again. To aid identification a plate and description are given.

Castellia tuberculosa (Moris) Bor comb. nov.

Catapodium tuberculosum Moris in Atti Terz. Riur. Sc. Ital. (1841) 481.

Castellia tuberculata Tineo, Pl. Rar. Sicil. II (1846) 18.

Festuca tuberculosa Coss. et Dur., Flor. Alger, Glum. (1856) 189, t. 14.

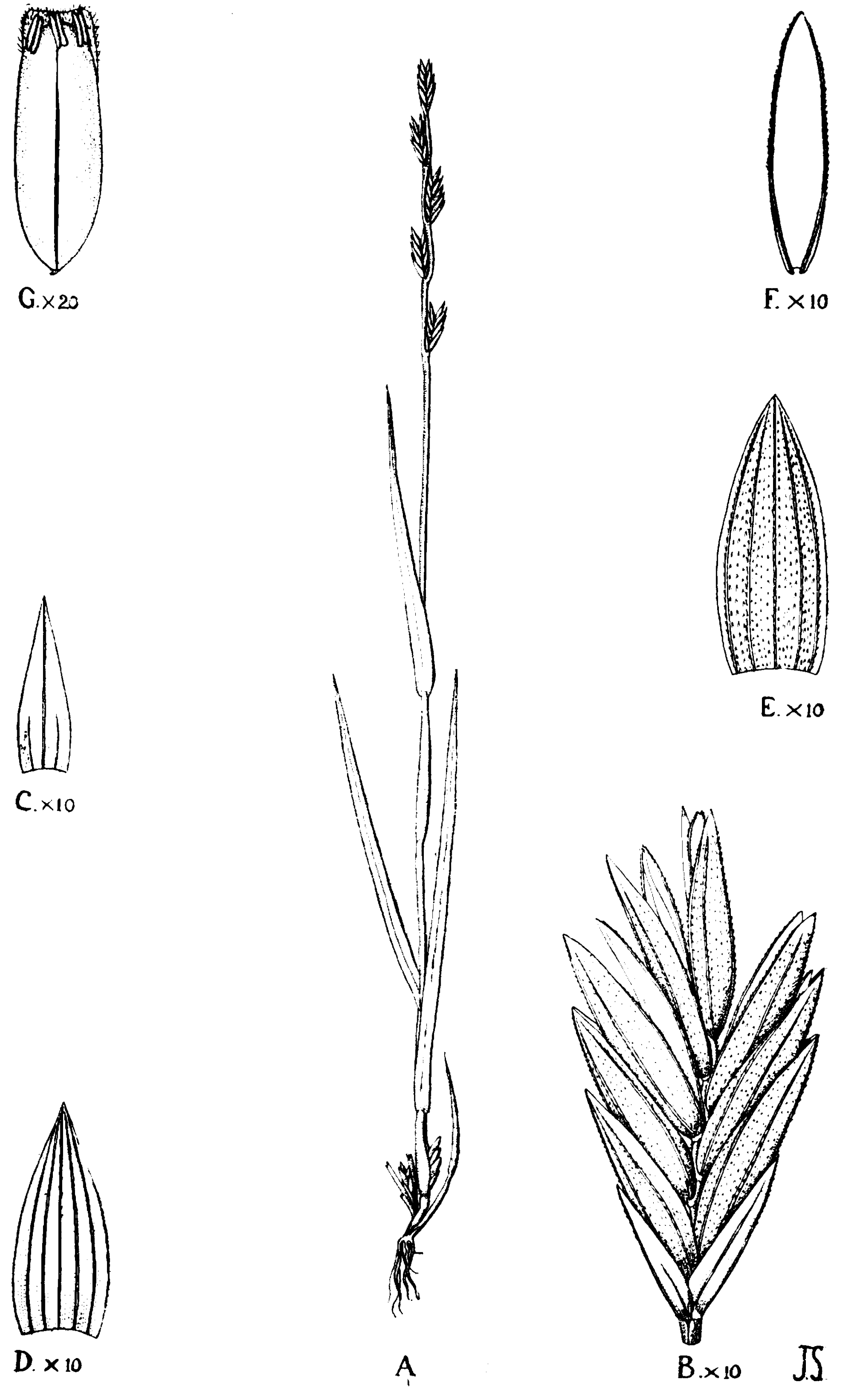
Festuca tuberculata Benth. in Jour. Linn. Soc. 19 (1881) 128.

Desmazeria tuberculosa (Moris) Battand, et Trabut, Flor. Alger. Monocots. (1884) 100.

An annual grass. Culms simple, often several arising from the base, up to 30 cm. tall, smooth and glabrous, wiry. *Leaf-blades* soft, flaccid, green or somewhat glaucous above, scabrid on the upper surface and on the margins, scaberulous below, glabrous, strongly nerved below; sheaths rather inflated, especially below, smooth and glabrous or scabrid, striate; ligule a hyaline membrane 1.5 mm. long, erose at the top.

Inflorescence, a simple spike or a raceme of spikes. Spikelets 9-15-flowered, arranged radially to the axis (*i.e.* with the backs of the lower glume and first, third, etc. lemmas against the rhachis), when young oblong-acute at both ends, when older oblong-wedge-shaped, 10-13 mm. long, seated on very short pedicels, alternately arranged on either side of a strap-shaped axis which is shallowly concave opposite the spikelet; rhachis smooth and glabrous. *Spikelets* all apparently cleistogamous and in addition to those in the panicle, single spikelets or short racemes of spikelets are to be found within all the sheaths even those at the base.* *Lower glume* 3.5 mm.

* One interesting point about this grass is that *all* the florets seem to be cleistogamous. Even those florets in the well-developed raceme show the small anthers crushed on top of the mature grain. Hakel mentions this species in Oesterr. Bot. Zeitschr. (1906) 148, and states that it exhibits both cleistogamy and chasmogamy in its native home.


G. ×20
F. ×10
E. ×10
C. ×10
D. ×10
A
B. ×10
J.S.

long, lanceolate-acuminate in shape, coriaceous except for the outer margin which is hyaline, smooth and glabrous, 3-nerved, with its back touching the concave surface of the rhachis, usually with the base not occupying the entire extent of half the top of the pedicel but usually only one quarter. *Upper glume* 4 mm. long, 1 mm. wide, oblong-obtuse in shape, 3-nerved, uniformly coriaceous in texture, curved on the back, smooth and glabrous. *Lemmas* 4.5. mm. long, ovate-elliptic-obtuse when flattened, slightly keeled when young, rounded on the back as the grain matures, conspicuously 5-nerved, rather delicate in texture and translucent, glabrous, covered all over the back with rough tubercles, which are pale-straw coloured, or stained at the base with violet. Anthers .3 to .6 mm. long, usually found crushed on top of the grain. Rhachilla stout, scabrid, disarticulating below the florets. Grain 3.5 mm. long, oblong, acute at the base, rounded above, crowned with a fleshy process covered with short hairs; hilum straight linear, three quarters the length of the grain. Palea elliptic-oblong, shorter than the lemma, rounded at the apex, 2-nerved, keeled, scabrid on the keels and in the intervening space.

Jhalar near Campbellpur, April 1935. Coll. E. Nasir. Distribution: Spain, Greece, Lampedusa, Canaries, Algeria, Marocco, Italy. (Herb. Dehra Dun).

Up to the present time this grass has been known under the name of *Catapodium tuberculosum* Moris (a name also adopted in this narrative account) but it has also been referred to *Festuca* Linn., *Desmazeria* Dumort. and to *Castellia* Tin. Advantage was taken of its discovery in India to determine its correct taxonomic position.

The type species upon which the genus *Catapodium* was erected was the grass originally described by Linnaeus as *Festuca marina*. It was also called *Poa loliacea* by Hudson. Link, in Hort. Berol. I (1827) 41, founded the new genus *Catapodium* on this species, and called it *Catapodium loliaceum* (Hudson) Link, not being aware of Linneaus' earlier name. In recent years *Catapodium loliaceum* has been transferred to the earlier genus *Desmazeria* Dumort* (Comm. Bot. (1822-26) by both Nymen and Druce. The latter made the correct combination *Desmazeria marina* (Linn.) Druce and the grass is now known by that name. It will thus be seen that with the transfer of the species upon which *Catapodium* was founded, to another genus, the genus itself disappears.

The question then arises, should not *Catapodium tuberculosum* Moris be also transferred to *Desmazeria* Dumort.? Apart from obvious morphological differences between our grass and the species of *Desmazeria*, an examination of the grain shows that there is no relationship between them. In *Desmazeria* the hilum is a small point on the grain at the base or just above it, indicating an affinity with *Poa*. In *Catapodium tuberculosum* the hilum is a linear groove which extends from the base for three quarters the length of the grain, and recalls vividly the hilum in species of *Festuca*. *Catapodium tuberculosum* has been referred to *Festuca* by several authors and in one case at least, a special section of *Festuca*, sect. *Castellia*, formed to accommodate it. There are two weighty reasons why our grass should not be transferred to *Festuca*.

These are : (1) the lemmas are very thin in texture, covered on the back with coarse tubercles and are awnless.

(2) the top of the ovary has a fleshy process which is covered with short sparse hair.

It is quite clear that *Catapodium tuberculosum* Moris is sufficiently distinct from *Catapodium*, *Desmazeria* and *Festuca* to be considered the type of a distinct genus of its own. Fortunately, the genus *Castellia* Tineo exists and was created by Tineo in Pl. Rar., Sicil. 2, (1846) 17 to accommodate this very species. Incidentally Index Kewensis quotes *Castellia* Tin. as follows: *Castellia* Tin. Pl. Rar. Sicul. 17 (1817). In point of fact Tineo published part 1 of his Pl. Rar. Sicil. in 1817 but this part does not contain any reference to *Castellia*. The genus is actually mentioned in part II p. 17, published in 1846, and a description of this species is given on p.18 where the species is called *Castellia tuberculata* Tineo.

* Dumorier named this genus after his friend Desmazieres but published the name as *Demazeria*, apparently in error, for, in all his subsequent publications in which the genus is mentioned, he spelt the name *Desmazeria*. The latter spelling is that now generally accepted.

Hence the epithet, used by Moris in 1841, *tuberculosum*, has priority over *tuberculata*, adopted by Tineo five years later and it seems that the plant should receive the name *Castellia tuberculosa*. A search of the literature has not shown that this new combination has been made previously although *Castellia tuberculosa* Tin. does occur in synonymy under *Desmazeria tuberculosa* in Battand. et Trabut, Flor. Alger Monocots. (1884) 100.

In this paper *Castellia tuberculosa* (Moris) Bor is adopted as a new combination.

(*a*) Castellia tuberculosa (Moris) Bor.
(*b*) Spikelet.
(*c*) Lower Glume.
(*d*) Upper Glume.
(*e*) Lemma.
(*f*) Palea.
(*g*) Grain.

ON WORKING PLANS

By Professor E. P. Stebbing

G/1143, 630/Gn.—The system of fixed periodic blocks possibly best meets requirements, conversion plans being the necessary corollary, for India. The importance of sound working plans and training therefore is stressed in the foreword.

The highest type of working plan is perhaps that under the fixed periodic blocks, wherein highly intense silviculture and forest management are combined and continuity of management ensured.

A working plan is equally so for new afforestation on bare land as for a mature forest, even if 5 years each. The study of past forest history by the first w.p.o. is emphasised and a careful study of the elaborated method of Western Europe.

Foreword—We are indebted to Prof. Stebbing for his note on Working Plans which was actually written as a contribution to the 5th British Empire Forestry Conference. Few of us in India well disagree with him that there is much to be learnt from working plans of Western Europe and that the system of fixed periodic blocks introduces, possibly, the most satisfactory form of management. In India the opportunity for using the uniform shelterwood silvicultural system is not great, but conversion plans, with artificial regeneration, are establishing gradually fixed periodic blocks. The importance of sound working plan prescriptions in the numerous revisions now or about to be undertaken in India cannot be over-emphasised. It is all very well to say that working plans are essential to ensure continuity and to prevent tampering with the forest, but they must be sound, workable plans. There is no more important branch of forestry ; in the training of a forest officer working plans and working plan instruction should form the coping stone to all lectures and practical work. Every professional forest officer should prepare at least one working plan during his service ; not only he, but the department also, will be benefited.

—A. P. F. Hamilton.

The insistence on the Working Plan of Western Europe and its non-adaptability to other conditions in countries outside Western Europe I find it difficult to understand.

Possibly one of the highest types of Working Plan devised is that prepared *under the fixed* Periodic Blocks laid down on the ground with fixed boundaries worked under natural regeneration *on the Uniform or Shelter Wood Compartment* method ; the regeneration period in the Regeneration Block being based on the rotation and the *number of periodic* blocks *on the* number of years laid down for the regeneration of a Periodic Block.

Once introduced upon the ground and a degree of normality brought into the growing stock, the volume of timber etc. per year and per period of years can be calculated with fair certainty. As also a correct regulation of thinnings and the amounts of material yielded by them.

Here we have Silviculture and Forest Management brought to a high degree of intensity. Overfelling is a practical impossibility ; but as, important, the gradual improvement of the forest soil advances with the Centuries. The Working Plan and its prescriptions have resulted in this state of affairs.

The modification known as the Floating Peiodic Block, applicable to very abnormal forests, is too well known to need more than a mention here.

There appear to be those who, having made some acquaintance with the high degree of Forestry science and practice, as exemplified by the Fixed Periodic Block method, say—Oh, that is not for us, quite impracticable for us. The Working plans of Western Europe are no good to us. May not this attitude be due to the possibility that they have not throughly appreciated the main underlying reason of the Working Plan. What is it ?

Merely to introduce such a management on the ground—area to be afforested or area already under forest—that a continuity of management shall be maintained. The whole underlying theory of the Working Plan is to ensure a continuity of Management. Officers may come and Officers may go ; an Officer may hold one set of ideas, another opposing ones. But none of these can introduce their vagaries into the management of the area—let alone over-felling or over-thinning ; for the Working Plan in force provides the safeguards against these practices, once it has received the sanction of the Higher Authority.

As to the Working Plan itself.

It has already been pointed out in the Conference that Working Plans may be of simplest. A tiny village forest or a small forest belonging to a town council of a small town. A Working Plan may be prepared in a simple form for each. There are many of the type in France, all prepared by the Government Forest Officer, but managed by the village or town ; all marking of fellings being undertaken by the Government Forest Officer. These are not complicated Working Plans. The provisions are of the simplest. But they are made to ensure continuity of working, continuity in management, if you will.

I heard a Senior Officer say a year or so ago—Oh, I don't want Working Plans. They would restrict my activities and prevent me making alterations in the work when I wanted to. Note the 'my' and the 'alterations.' Alterations and modifications may be necessary to a Working Plan while being worked. But since the Working Plan has been sanctioned by the Government of the country concerned on the advice of the two of the highest Forest Officers concerned, it is only these Authorities who can sanction modifications. Herein lies the safeguard of any and all Forests, once placed under a Working Plan.

A Working Plan is no less a Working Plan because, for instance it is drawn up for a period of 5 years, only deals with the new work being carried out by afforesting an area of bare land, with the accompanying drainage work, compartment lines and road outlay, nursery work for provision of plants and so forth.

A Working Plan is no less a Working Plan because it is drawn up to arrange for fellings in mature forest for a period of 5 years based on a rough enumeration of the growing stock or stocking of the merchantable species, so as to put an end once and for all, to over-felling. If the Officer carrying out the rough enumeration can record some notes on Silviculture and other forest lore of the most elementary nature, our Working Plan will thereby at the start, be something more than a mere felling plan. And the young Forester nowadays is trained to that very end. Though little advantage in some parts of the world has been taken of this training.

How much unchecked, because unknown, over-felling in forests all over the world, where no enumeration of the growing stock has ever been undertaken, has been carried out during the late Great War ? India is probably one of the few countries where the extent of the extra War Fellings in her forests is known, and where by the closure to felling for a period of years, estimated at from 10 to 15, the War Demands will be made up. But these forests have been under Working Plans, as Mr. Hamilton has told us, for a long period of years.

Coming back to the Western Europe Working Plan, which is apparently so much feared or misunderstood. I suggest that once a young Forestry student has prepared, under supervision, a Working Plan on the Fixed Periodic Block Method mentioned above, with all its complexities in the case where the growing stock is not normal in the several periodic blocks—once the drafting of a Working Plan under these exacting conditions has been mastered, I would confidently entrust to *him* the preparation of a Working Plan of any simple type—new afforestation area, small village forest, town forests (especially the firewood fuel

type), City, Corporation with the great Catchment Area of its water supplies, up to the forest best loved of many Forest Officers, the type which produces solid timbers for the big markets and a satisfying financial return.

There is one point in connection with all first Working Plans I should like to mention.

The ordinary contents of Part I of any Plan, have been alluded to in the Conference. But there is one factor in this connection which has not so far been stressed. The absolute necessity, in fact the direct responsibility, laid upon the first Working Plan Officer to study the Countryside and its past history, including of course the forest region, in as intimate a degree as possible—not merely the Ordinary topography, geology, climate, population and its requirements, and so forth. As important, perhaps in some cases more important in the first instance, is the study of the past history of the region, much of it lost in obscurity, but probably still traceable by the Forest Officer enquirer.

I regard this as a matter of the first importance. If placed on record now it may prove of considerable value in the future. The important point to be borne in mind is that if the first Officer to make a Working Plan in the region does not carry out this study, subsequent Officers, engaged on revising or redrafting the Working Plan will not do so. If they think about the matter at all, in most instances they will assume that the first man instituted such enquiries and included all he could find out in the first Plan. I have heard this omission of the past deplored in the case of many Working Plans I have studied, especially information shedding light on the former condition of the area for which the Plan is being specially made.

Finally, as to the idea that the Working Plans of Western Europe are of no use to us in the British Commonwealth I myself, to be perfectly frank, regard this as pure moonshine or based on misunderstanding.

Learn how to make a Working Plan on the methods elaborated in Western Europe by much trial and error, intensive study of the Silviculture of the species they were making use of experience gained in the making of the thinnings and the marking of the trees for the major fellings.

Having done this I believe that a man armed with this knowledge is in a position to size up any area for which a Working Plan is required and decide with comparative ease on the lines, degree of intensity or elaboration, and so forth, that the Plan is to be drafted.

WATER-LOGGED AREA IN ATTOCK DISTRICT

By Mohammad Said, P.F.S. (Class I).

Divisional Forest Officer, Attock S. C. Division.

S/12 and 46/Pj., G/1216 and 285/Pj.—The problem of dealing with a water-logged area in Attock, near the Indus is discussed. Afforestation of denuded Malakmala hills is suggested. A study of a soil profile disclosed predominance of clay in the problem area.

An area of about 6000 acres in the North-west corner of Attock District and near the left bank of the Indus river is water-logged. It mainly lies round about the villages of Hazro, Shamsabad, Mansar, Jatial and Musa. Its aeration is poor and the water table is very high. During the rainy season water stands up to the depth of 4″ to 5″ at many places while in the winter it is possible to raise poor and sparse crops near drainage channels.

Various arguments have been put forth to explain the water-logging of the tract. Some believe that the high hills surrounding the area discharge many torrents into it and cause water-logging. Others attribute the high water level to the semi-artesian effects in the area. Whatever may be the causes of water-logging there is no doubt that destruction of tree growth on Malakmala hills, which are about 2 to 3 miles from the tract and from where various destructive hill torrents originate, has upset the natural equilibrium of water distribution and the only hope of reclaiming the land lies in protecting and afforesting the catchment area first.

A part of this area has been included in the Gangarh catchment area working plan. Under this plan digging of field to field drains has

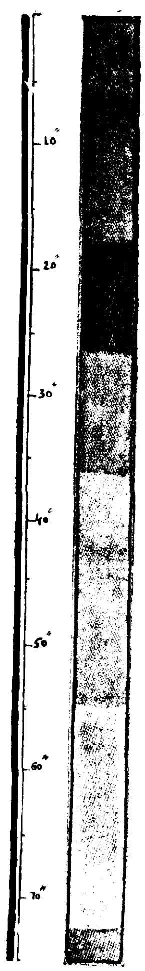
been provided. Besides this, the areas, which are lying waste are recommended to be transformed into village plantations. The following species have been suggested :—

1. *Eucalyptus spp.*
2. *Willow.*
3. *Frash* (*Tamarix articulata*)
4. *Azadirachta indica*
5. *Populus euphratica*

The planting has not been tried on an extensive scale as yet. A small area in Jatial was planted with willow, eucalyptus and *frash* with good success.

A study of a soil profile near Musa village was made. The results are given in the attached diagram. Due to non-availability of chemicals, acidic or saline properties and P.H. value of different profiles could not be determined. From the analysis it is clear that the proportion of clay predominates.

SOIL PROFILE
IN
WATER-LOGGED AREA near MUSA VILLAGE ATTOCK DISTRICT



Depth.	*Colour.*	*Description.*
6"	Light grey	Drainage impeded, root penetration of surface grass forms compact mating very hard clay with mixture of fine silt.
6"-18"	Grey	Clayey loam, with gradual increase in fine sand as the depth increases.
18"-26"	Dark Grey	Loamy soil with higher clay content in top layers and more sand in bottom layers.
36"-43"	Brownish grey	Clay with few fine micaceous particles, water-logged here and below.
43"-53"	Light grey	Hard compact clay with shining micaceous particles, completely water-logged.
51"-73"	Light brown	Hard compact clay with shining micaceous particles completely water-logged ; traces of Kaukar formation are frequent.
73"-75"	Brown	Loam to sandy loam with increased percentage of fine sand lower down.

General. Proportion of clay is predominant and consequently the drainage is bad. The profile presents a water-logged appearance below $2\frac{1}{2}$ ft.

THE TAMUR VALLEY EXPEDITION

BY J. BANERJI, I. F. S.

Chapter I—Entry into Nepal.

G/1133-21, 1133-31, 262, 343/In., S/101, 102/In.—References are made to notable travellers on the Himalayan route to eastern Nepal, now re-done in March 1947, to explore practicability of a 750 feet high dam on the Kosi, which has a catchment of 23808 sq. miles, nearly a tenth of which is under glaciers, calculated to generate nearly a million-and-a-half of firm kilowatt power, provide perennial irrigation to Nepal and Bihar and to stop floods.

The Darjeeling forests protect the upper hills in contrast with the denuded Nepal slopes. The three types of forest of the Singalila range are described and the trek to Phalut and thence in the Kabeli valley.

In November 1848, Sir Joseph Dalton Hooker, F.R.S., made a memorable journey into the hearts of the unknown and unexplored Eastern Nepal at a time when the venture could not but have been extremely risky and dangerous. In his inimitable manner he described the journey in the 'Himalayan Journals', published in 1854, which still remains a monument of hard work, and a storehouse of botanical, geographical, and geological information about this still forbidden land. Every lover of nature, all those who love the mighty Himalayas, and all naturalists and forest officers will always find this book a source of inspiration for exploration of unknown tracts and forests. It was recently the good fortune of the author to cover practically the same route as followed by Hooker, and compare, mile after mile, the condition of the country to-day with what it was a century ago. It can be confidently stressed that similar comparative studies of routes followed by early travellers, such as Hsuan Tsang in the seventh century, Fa-hsien about 400 A.D., and Marco Polo in the thirteenth century, can bring to light many significant facts for a policy of comprehensive land-planning. Some modern explorers and journalists, such as Sven Hedin, Aurel Stein, C. P. Skrine, Owen Lattimore, and Peter Fleming have added their contributions to such studies; the latest is 'Delhi-Chungking' a travel diary by K. P. S. Menon who traversed a portion of the early silk-route. Louis Golding's 'In the steps of Moses' is also a study in the right direction. At a time when our new independent country is trying to build a solid foundation for a brilliant future, such studies will show the necessity, the importance, and the inevitability of a comprehensive planning of our land resources before it is too late to mend matters.

The Central Waterways, Irrigation, and Navigation Commission is now seriously engaged in one important branch of these nation-building activities, and is investigating the feasibility of a high dam across the Kosi a few miles above Chhatra, where it debouches into the plains of North India through a series of narrow gorges. The Kosi is the third biggest of the Himalayan rivers, being next only to the Indus and the Brahmaputra. Its catchment area is 23,808 square miles, of which 2,228 sq. miles are under glaciers. The height of the dam above the rockbed is estimated to be 750 ft. the highest in the world, and the reservoir will have a storage capacity of about 10.6 million acre feet, with a submerged area of about 74 sq. miles. It will be possible to generate 1.4 million kilowatt of firm power, in addition to considerable quantities of secondary power. The project will provide for perennial irrigation of extensive areas in Nepal and North Bihar, and navigation facilities throughout the year from the dam site to the Ganga. Finally it will permanently put a stop to the annual devastating floods of the Kosi, which have been the ruin of thousands of acres of extremely fertile lands in North Bihar. A vast scheme of this nature is bound up with a detailed study of the land management and soil conservation methods in the upper catchment area of the Kosi, so that the expected life of a century for the reservoir can be insured. The Central Himalayan range is, again, the abode of eternal snow; it was therefore considered desirable to study the density, depth, and the amount of the annual snow cover in the upper regions, so that steps might be taken for reasonable annual forecast of the spring discharges of the river for the benefit of agriculturists, and irrigation engineers. Under the auspices of

the Central Waterways, Irrigation, and Navigation Commission, an expedition was therefore organized in March 1947 to penetrate into Eastern Nepal, and collect the necessary data.

The first section of the journey, consisting of three stages, was the well-traversed route from Darjeeling (6,900 ft.) to Phalut (11,799 ft.) via Tonglu (10,074 ft.) and Sandakphu (11,911 ft.). This stretch is well-known to the forest officers of Bengal, and the many tourists and military officers who flock to these mountains once every year in summer to be alone with Nature, and her awe-inspiring and magnificent views. There is a well-gradiented jeep-track up to Kalipokhri, four miles below Sandakphu, beyond which the track is too rough and narrow even for the all-powerful jeep, though the gradient is easy for horses, mules, and trekking. There are excellent bungalows for tourists at Tonglu, Sandakphu, and Phalut, for the occupation of which a written permission is necessary from the Deputy Commissioner, Darjeeling.

We started from Darjeeling on a cold oozy morning on the 17th March, 1947, and reached Tonglu (10,074 ft.) the same evening. Motor transport was possible up to Manebhanjyang, down the well-graded road recently constructed by the forest department between Sukhiapukri and Manebhanjyang. One need not go to Simanabasti to reach Tonglu as was necessary in Hooker's time, up to a few years ago. The reserve forests of the Darjeeling forest division on the way, it was found, ably protected the upper slopes of the hills; reservation, it seemed, was probably made specifically to protect the upper reaches of the Ramman, an important tributary to the Tista. At Manebhanjyang, where both the Nepal and the Darjeeling sides of the hills were visible, it was evident that while the forests of the Nepal side have been slowly destroyed laying the surface soil on the slopes dangerously bare, those on the Darjeeling side stood to the credit of the foresight of those early pioneer forest officers who selected them for reservation. In addition to protecting the steep hill slopes from the devastating effects of soil erosion and constant gully formation, these forests supplied the vital needs of timber and fuel in Darjeeling.

This section of the journey was along the narrow top-ridge of the Singalila range, which is a southern spur of the Kanchenjungha group of peaks, clearly visible from Darjeeling as a solid wall to the west. Not only does this range form the watershed between the Kosi in Nepal, and the Tista in Sikkim, but also constitutes a *vegetational divide* between the moist flora of the Tista valley, and the comparatively drier associations of the Kosi basin. It stands towering across the path of the monsoon clouds, most of which fall as rain to the east of it and to the south of the Mahabharat Lekh range, leaving a comparatively dry corner between the two. The highest peak of the Singalila is 12,095 ft. in height, and is about three miles to the north of Phalut bungalow. A magnificent view is obtained, from the top, of the vast panorama of mountains and snow. The snow-clad mass of Kanchenjungha is immediately to the north; to the east miles and miles of hill ranges in Sikkim with tree-clad valleys are visible; the Mahabharat Lekh range stretches out to the south with undulating peaks, while to the west, one sees the deep valleys of the tributaries to the Tamur, covered in patches with close forests of *Tsuga brunoniana*, *Abies densa*, and various *Rhododendrons*. The view of the Everest and Makalu from the Phalut bungalow has been watched and described and photographed by many a tourist. Many people take this trip only to get this mighty view of the highest peak of the world.

The forests of the Singalila range can be classified into three elevational types; the lower, the middle, and the upper. The type of vegetation found in the lower zone up to about 5,000 ft. is mainly a *Castanopsis Schima* association, with a moderately thick herbaceous undergrowth covering the ground. The type in the middle zone consists of overmature stems of *Quercus pachyphylla*, *Quercus lamellosa*, *Castanopsis hystrix*, *Machilus odoratissima*, *Michelia excelsa*, *Michelia Cathcartii*, *Magnolia Campbellii*, and numerous other broad-leaved species. Trees are stag-headed, gnarled, and festooned with moss and lichens. *Rubus*, *Viburnum*, *Strobilanthes*, ferms and bamboos abound. There is often a tangle of herbaceous species covering the ground, which is in great demand for fodder. This type extends up to about 8,000 ft. higher on southern slopes, and lower on the northern, due to different intensities of insolation. The type of the upper zone begins with thick masses of *Arundinaria maling* at about 8,000 ft. and then successive belts of (*i*) *Quercus pachyphylla*, *Magnolia campbellii*, and *Acer* Spp., (*ii*) almost pure crops of *Tsuga brunoniana*, with belts of

Rhododendrons, and finally (*iii*) *Abies densa*, with *Betula utilis*, and *Rhododendrons*. These forests have been destroyed over extensive belts by fires, and consequently they are often open and patchy. Large pasture lands are interspersed amidst these forests, covered with coarse grass and *malinga* bamboos. Hooker noticed similar havoc caused by fire to these forests over a century ago. It seems to be a chronic disease to set fire to the forests everywhere, whenever the villagers are in need of pasturage.

There was about 3″ of snow in patches around Tonglu on 17-3-47, which was fast disappearing. There had probably been a snowfall here a few days ago. The next morning, as we started, we faced a cold north wind blowing down the valley at 15 miles per hour. Between Tonglu and Gairibus the Bengal preservation plot No. 14 was inspected, which was visited again on 19-4-47 on the way back, when *Rhododendrons, Magnolias*, and *Daphne* in a mantle of gorgeous flowers made the whole hillside look like a grand flower show. From Gairibus, which is at the bottom of a descent and consists of a hut or two built by road coolies, a steep ascent began amidst poor visibility. After three hours of march through *Malinga* and *Quercus* areas, we reached Kalipokhri, a village with about a dozen huts, and a small tank, which gave the name to the village. Such tanks, or collection of water in small depressions, were found all along the ridge of the Singalila range, due, presumably, to the existence of a fault-plane along it. There was a welcome short-cut from Kalipokhri to Sandakphu on the Nepal side, while the main track skirted round the brow of the ridge on the Indian side. Beyond Kalipokhri we came across for the first time small snow drifts along depressions under cover of *Abies densa* at an elevation of 11,000 ft. When we reached the Sandakphu bungalow, we found it covered with 12″ of snow all round.

There was a strong cold wind from the north all throughout the night, searching every corner of the snug bungalow. The minimum temperature at night was 24.5°F. On 19-3-47 the stage between Sandakphu and Phalut (13 mi) took about 10 hours. The ground was everywhere covered with 12″ to 18″ of snow; the strong, cold, northerly wind continued throughout the day, and in the evening near Sandakphu we were overtaken by a biting snow blizzard. At every step men were sinking down to their knees; the snow blizzard made it difficult to keep one's balance on the bare steep hillsides. The porters with their load of 70 lbs. each struggled up in a long straggling line. At places the path lay along razor's edge on the ridge with precipitous ice slopes on either side. One false step would have meant a fatal glissade down a 500 ft. snow-covered precipice. *Abies densa* stood majestically on the white snow-covered slopes hundreds of feet below. *Anaphalis contorta*, *Gnaphalium triplinervis*, and *Rhododendron lepidotum* stood the hostile weather in silent prayer, buried in snow almost up to their leading shoots.

It was dark when we reached the Phalut bungalow (11,799 ft.) at the end of a steep ascent. Everyone heaved a sigh of relief when he stepped on the welcome verandah of the rest house. The snow-blizzard, however, increased in violence every minute. The howling wild wind struck the bungalow on all sides, slapping everybody on the face, if one dared to peep out. Soon a cheering fire was lighted in the sitting room, the porters had a drink of hot tea, and after a hurried dinner, they huddled themselves together in twos under blankets. As we were discussing the exploits of the day round the fire it was reported that one porter had not reached the bungalow yet. No one would dare to venture out in search of the missing porter in this dangerous and inclement weather for love, or lure of a reward. As I was getting ready to go out to fetch the unfortunate porter in my snow-boots, American leather jerkin, and heavy army overcoat, Ang Tharkay, the well-known Sherpa Sirdar who was in charge of the porters with us, and who was a hero of Mount Everest and Nanda Devi Expeditions, volunteered to go out himself; with him came his sturdy brother-in-law, Shirki. Both of them shot out of the bungalow in the dark ferocious blizzard outside, with a torch that hardly lighted a few feet around. They slid down the snow-covered slope, and after a quarter-of-an-hour's search found the dazed porter almost buried in snow half a mile below. They carried him on their back, and brought him to the bungalow in about an hour, displaying true manly courage and endurance. The porter's heart was feeble, his extremities cold and numb, and he could not speak. A little brandy with hot water, and vigorous

massaging of hands and feet near the fire brought him back to life in about fifteen minutes. There was then joy in the camp again.

Our programme drawn from the office table at New Delhi was to proceed beyond Phalut northwards along the Singalila range to Gharakhet La (14,108 ft.), and then turn north-westwards into Nepal. No information on the condition of this route during this season was available anywhere: only a precarious footpath was shown on the old ¼″ survey of India map. On the morning of the 20th March, as we looked northwards, we found the whole country covered with a deep mantle of white snow, as the snow-blizzard had continued the whole of the previous night. The path was covered with 24″ to 30″ of snow, and it could not be located in the all-pervading snow. We had two courses open to us: either to wait at Phalut for about a week till the snow melted, or to go back to Darjeeling to return later, when the weather would be less formidable. Both these were unacceptable to the enthusiastic members of the party; we then held a conference, and studied the map of the locality to discover if there was any other course available. The watchman of the bungalow, and some of the porters who had been on this route previously with tourists in summer, gave us the benefit of their local knowledge. It was found that if we cut straight down to the west, we should meet the Inwa Khola, a tributary to the Kabeli, which itself joined the Tamur below Taplejung. Once we went below 11,000 ft, there would be no snow to traverse. We therefore decided to enter Nepal at Phalut, and to approach Gharakhet La from the north later after about three weeks, when, it was expected, all the temporary snow would melt.

We had a day's halt at Phalut to re-calculate the rations that would be required in the new altered route and it was found that no basic change was required. We therefore started for the unknown Kabeli Valley on the morning of the 21st March 1947. There had been more snowfall the night before, and walking under such conditions was extremely difficult and dangerous. Early in the morning at about 6.30 a. m. a glorious view of the Kanchenjungha group of peaks was obtained only for a short time. In the dull steely morning light, with a white mantle of snow all round and a biting cold wind benumbing the extremities, the majesty of this mighty Himalayan peak, second only to Everest, struck us all with awe and wonder for the architect of this prodigious mass of granite and snow. Blue streaks of glaciers were hanging from dizzy heights, which, as the sun shone upon them, assumed the brilliant hues of the spectrum. Of all the visible gigantic peaks, the Kanchenjungha was the most gigantic, a monster amongst monsters. The majestic upward sweep of the snow-clad ground culminated in a more majestic cone of steely blue ice. The Kanchenjungha eternally flaunted in defiance her banner of snow and ice in our faces. She meant to remain unconquered for ever.

As a long and unknown journey remained to be undertaken, we soon took our eyes off from the mighty peaks, and turned to proceed northwards for a short distance. This we did with extreme difficulty for about half a mile and then it was found impossible to proceed any further. The path was lost in the all-pervading snow and at places snow was more than 36″ deep. As men slumped into these patches, there were roars of laughter from the porters behind. These simple children of nature were known to smile even in most tragic circumstances. They still remained unsophisticated. Shortly we made a sharp turn westwards, and started sliding down the steep snow-covered slopes on the Nepal side of the Singalila range. Steps had to be cut by an advance party, and properly stamped down, before the main body could proceed.

The first furlong or two down the ridge, the ground was generally bare. The western slopes of the Singalila range, which fall within the territory of Nepal had been denuded of forests in many large belts, and *Abies densa* which was very frequent on the wet eastern Sikkim slopes generally better protected, was less common on the dry western Nepal slopes. After descending through scattered groups of dwarf *Rhododendrons* and *Arundinaria racemosa*, and *Daphnne* almost buried in snow we met at about 9,600 ft. (718 millibars) denser forests of *Rhododendron Falconeri*, *Rhododendron cinnabarinum*, *Betula alnoides*, *Acer*, *Hydrangea* (40′ in height, 4′ in girth) *Daphne*, and *Rosa*. There was about 1″ of snow even here from the previous night's fall. After a few minute's descent, *Berberis* disappeared,

but *Rosa* persisted. At about 9,000 ft. snow completely disappeared. This was on the north-western slope of the range; on the southern slope snow persisted down to about 10,000 ft.

After three hours of continuous descent, we came across the first signs of habitation a stone hut with mud plaster, and woven bamboo-mat-roofing. This was obviously a hut built by graziers to be used by them on their way up or down. Vegetation was cleared round the hut. *Taxus*, *Viburnum*, and *Malinga* were found in scattered groups on the hillside. The steep descent was continued for another hour till we penetrated into a thick belt of *Qyercus* and *Castanopsis*, with *Polygonum*, *Hypericum*, and *Zizyphus*. Half an hour later, after cutting through dense undergrowth of *Rosa*, *Neilia*, and *Arundinaria*, we reached the banks of Thare Khola, a tributary to the Inwa Khola, which itself is an important tributary to the Kabeli. It was about 6′ broad at that season, with a foot of water rushing down from boulder to boulder along its steep, almost precipitous valley. Huge rocks, 30′ to 40′ in diameter blocked its course every few yards. Its steep banks were covered with dense forests of *Michelias*, *Magnolias*, Oaks, *Litsea* and bamboos.

Suddenly two heads appeared from the dark forest on the other bank. We were all surprised, as we had not seen a single villager for the last few days. On questioning it was found that they were two Nepalese policemen, who had come to give us protection, on receipt of advance intimation given earlier to the Nepalese outpost at Chyangthapu village below, towards which we intended to proceed. Sitting on the cool banks of the 'Thare Khola' we had our lunch from packets of 'K' rations. Though these were old, we thoroughly enjoyed the hard biscuits and pieces of chocolate after the steep and strenuous descent. The Nepalese policemen enjoyed immensely the two pieces of chewing gum, a thing which they tasted for the first time in their life, and probably inwardly sang the glory of modern American civilization, which kept one's jaw moving eternally.

After an hour's march along the right bank of the Thare Khola, through a thick *Castanopsis oak-Schima* association, we reached Phedi, a small Nepalese village in the dark and deep valley with about 12 huts, built of bamboo walls and bamboo roofing. Three families lived here, raising a meagre crop of maize on the hill slopes. Virgin forests even on steep slopes, were felled, an indifferent crop was raised for a year, and then the area was allowed to remain fallow for two years. This system led to bad sheet erosion over a number of fields, which had been abandoned. A number of landslides had occurred around this village.

Below Phedi, the Thare Khola flowed alternately through narrow gorges and wide stretches. Along the wider stretches, on the shingly beds, there were excellent young crops of *Almus Nepalensis*, while along the banks, there were dense pole crops. Thick groves of *Edgeworthia gardneri*, with delicately scented globose flowers, were frequent in the open. Hooker found this species above Taplethok in the Tamur valley; this was equally frequent in the Kabeli valley. The immediate banks of the river were successfully protected by profuse growth of *Colebrookia*, *Artemisia*, and *Buddleia*. After two hours of march along this narrow winding river valley, we suddenly came upon the broad valley of the Inwa Khola, coming from the right. Straight in front, below the junction of the Thare Khola and the Inwa Khola, there was the large village Chyangthapu, on a wall about 100 ft. high across the joint course of the rivers. The combined river skirted round the base of the wall, and cut a narrow and deep gorge through it on the left. This wall presumably represented the ancient terminal moraine of the glaciers that came down the Inwa Khola, and the Thare Khola valleys in a bygone ice-age. Large boulders lay scattered and perched all over the ground at fantastic angles.

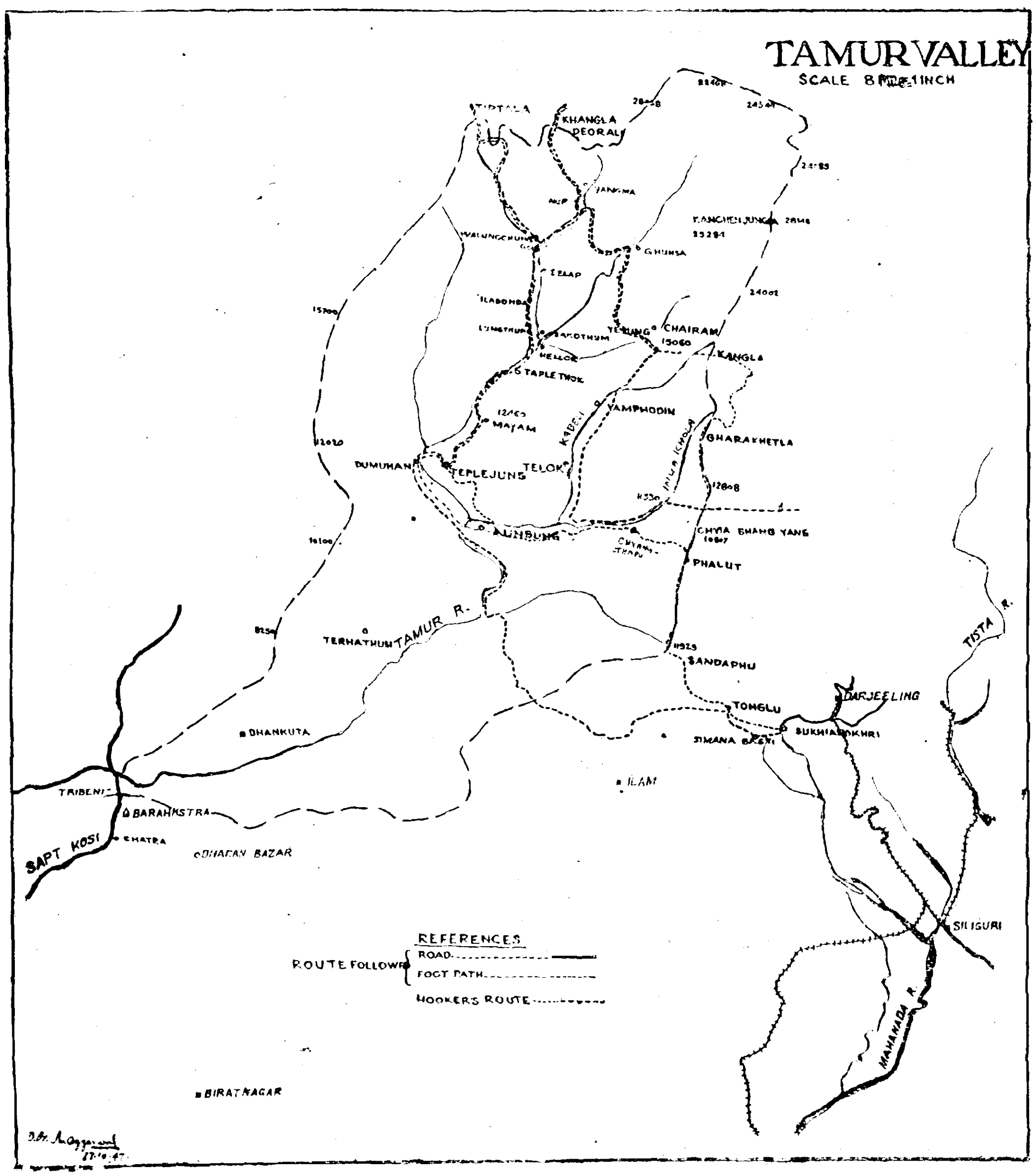
Chyangthapu was a prosperous Brahmin village with about 100 houses. Rice , maize, potatoes, wheat, barley, and 'phaper' were grown on hillsides. The rice fields were the lowest on the slope, with assiduously built bench terraces to protect the soil. They grew about ten varieties of rice round this village. There was no attempt at terracing for the other crops; consequently sheet erosion was frequent on such fields.

Peach, orange, guava, and an edible ficus were noticed scattered in a few gardens. Plantains were plentiful round the villagers' compound. The giant bamboo, *Dendrocalamus*

sikkimmensis, with diameter of about a foot, was growing in clumps near the river bank. *Euphorbia pulcherrima* was a favourite plant in the hedges.

We camped for the night in the hut of a respectable Brahmin, who allowed us to get in after satisfying himself that we were really Hindus, and did not belong to any disreputable caste. A Brahmin was highly respected in this village.

Our doctor had a busy time at this village, which probably had never been visited by a qualified medical man in its history. As the news went round that we were prepared to give medicine to the sick and suffering dozens of villagers thronged round our hut for help. Most of them were suffering from sores, fever and cold, and digestive disorders. The worst case was that of an old man, who had tried to shoot a dog with a locally-made gun. As soon as he had fired, the barrel burst in his hand, and his forearm was smashed. It was about a week ago, and now the wound was fearful; gangrene had set in; no antiseptic was applied, and no treatment was attempted; he had little chance of surviving. Our doctor cleaned the wound, applied proper antiseptic, and neatly bandaged the ailing arm. As we were leaving the village, the man was finally advised to proceed immediately to Darjeeling to have his forearm amputated. May he live long!



THE IMPORTANCE OF THE METHOD OF APPROACH TO PROBLEMS IN FOREST HYGIENE WITH PARTICULAR REFERENCE TO THE EXPERIENCE IN THE PUNJAB

By A. A. Khan

S/631, 823, 944/Pj., G/0474, 244/Pj.—The intimate relation of tree diseases to siting of forest plantations and environment is pointed out, with reference to "Cedrus deodara" etc., proneness to damage from snow is traced to lack of forest hygiene, and vulnerability of plantation "Dalbergia sissoo" to conditions of irrigation and lack of a mixture.

Tree diseases have not received the attention they deserve from the foresters because being slow and insidious they do not become so obvious as the other causes of loss, *e.g.*, fires, grazing, etc. It is only when the disease develops to the extent of an epidemic and spreads over large areas of forest that the forester thinks of doing something although it may then be too late to prevent loss.

Another unfortunate experience of the past has been that whenever a disease forced attention, the emphasis was usually on the remedial measures. Everybody tried to work out the solution from the top without paying any attention to the real basic causes. It was just copying agricultural and horticultural principles which in many cases were not at all applicable to forest conditions. In forestry the influence of environmental conditions is far greater than the actual organism causing the disease. It is only a recent development in forest pathology that due attention to the environmental factors has been paid in the study of diseases. It is encouraging to note that by this method fruitful results have been achieved in numerous diseases which were impossible to be tackled under the remedial system of agriculture. It is being increasingly realised that analysis of environmental conditions which serve as factors predisposing to disease needs far greater attention than the control measures.

The old saying—'Prevention is better than cure'—being true for disease control in human beings and livestock is doubly true for forest crops. Because of the low value of produce the use of even the cheapest remedial measures is not economical in forestry. The real solution of the problems of forest hygiene lies therefore not so much in the application of remedial methods as in the use of preventive measures. For a thorough grasp of the preventive measures it is essential to understand the environment in relation to disease.

From the point of view of its influence on the health of the forest, the environment can broadly be classified into physical and biological. The physical environment can further be sub-divided into :—

1. Climatic factors :
   - (*a*) Temperature—frost, snow and heat.
   - (*b*) Light—number of hours of sunshine and the seasonal variation.
   - (*c*) Rainfall—total quantity, seasonal distribution, humidity, drought and water-logging.
   - (*d*) Wind—wind velocity, direction and the connection with exposure.
2. Edaphic factors :
   - (*a*) Soil texture.
   - (*b*) Soil structure.
   - (*c*) Soil atmosphere.
   - (*d*) Soil moisture.
   - (*e*) Nutrient status.
   - (*f*) Water-table—seasonal fluctuations.
3. Topography :
   - (*a*) Aspect.
   - (*b*) Altitude.

Biological environment can be sub-divided into :

(1) Man—lopping, grazing and burning.

(2) Micro-organism, *e.g.* Mycorrhiz, bacteria, etc.

(3) Inherent characterisitics of the trees including hybrid vigour and degree of resistance or susceptibility to various diseases.

It is not intended here to go into details about the specific effect of each of the above factors on the health of the forest because the interactions vary under varying conditions. It may however be noted that any one of the factors individually or together with one or

more out of the rest may primarily be responsible for the conditions favourable to disease. The disease causing parasites may be present in the forest but they do not cause disease to any noticeable extent unless adverse environmental factors have created in the trees conditions predisposing to the particular disease.

The fact that the disease is invariably the result of interaction of the host and one or more of the adverse environmental factors can best be illustrated by taking into account some of the important forest diseases of the Punjab that have resulted in great economic losses. Out of the coniferous species of the Punjab, *deodar* (*Cedrus deodara*) is the most valuable timber tree. Economic considerations necessitated extension of the species both by raising pure plantations as well as through preferential treatment in the natural forest during regeneration and tending operations. Some years after the beginning of the campaign, extensive mortality caused by *Trametes pini* was noticed in the young pole crops. The earlier approach to the disease control centred round the orthodox principle of remedial measures which prescribed cutting and burning of dead trees and trenching round the root system of affected trees to prevent infection of roots of healthy trees. This however did not check the spread of disease which became epidemic in some of the forests. In the end attention was directed to the study of environmental conditions and it was found that adverse site factors had resulted in predisposing the trees to the disease. It was for example noticed that the mortality was heavy in fir areas which had been converted to pure *deodar* plantations. Similarly mortality was heavy in higher elevations as compared to moderate elevations. It thus became obvious that the root cause of the disease was wrong selection of the planting site. Damp sites and higher elevations proved predisposing factors and the best preventive measure was to avoid such localities for *deodar* plantations. This was soon adopted as a policy and the reduction in the disease followed immediately.

In some of the mixed stands of *deodar*, spruce (*Picea morinda*) and *Kail* (*Pinus excelsa*), it was noticed that snow had uprooted a large number of *deodar* poles. An analysis of the environmental factors revealed that site being moist and unsuitable for *deodar* had predisposed the crop to *Fomes annosus* which partially killed the root system of the poles and thus exposed them to excessive snow damage. Here again the remedy consisted not in following the method of trenching round all the infected trees but selecting the correct silvicultural site suited to the needs of the species.

Peridermium Cedri is another disease which has caused a good deal of mortality in young *deodar* poles in moist valleys. The usual prescription of cutting the diseased branches and trees is decidedly not the best remedy as it ignores the real cause of the trouble. Proper diognosis based on the study of site factors reveals that the trouble is due mainly to growing of pure *deodar* crops in damp valleys and the indicated remedy is either to avoid such situations for *deodar* or to have mixed crops with other species like *kail* and spruce.

An interesting example of the complex interaction of several factors of environment in predisposing the trees to disease occurs in the case of *shisham* (*Dalbergia sisso*) forests. *Fomes lucidus* has caused considerable economic loss by killing *shisham* trees in large number, in most of the Punjab plantations and canal banks and roadside avenues. Mere cutting away of the diseased trees neither leads to the control of the disease nor to a satisfactory hygienic condition of the forest. Correlation of *Fomes lucidus* with environmental factors has shown that incidence of disease is markedly heavy where adverse soil conditions are present. Although interaction of soil texture and structure may have effects on growth vigour but the real limiting factor in the semi-arid climate of the Punjab is soil moisture. Fluctuations in water supply seem to result in the death of some of the roots and the fungus which is usually a saprophyte gets chance of entry. It is also observed that when these conditions prevail over large areas, the spread of the disease is particularly heavy in pure crops and *shisham* mixed with mulberry (*Morus alba*) is comparatively less affected.

Plecoptera reflexa is a serious defoliator of *shisham* and causes direct loss in the increment. The indirect loss by the defoliator is also serious as the defoliated trees being weak in health and vigour become an easy prey to *Fomes lucidus* attack. Control measures for the defoliator are connected with environment, and the proper manipulation of site factors

to prevent defoliator attack effects the fungus both directly and indirectly. It is for example established that increase in flora of *shisham* plantations increases parasitic and predatory fauna of the defoliator. Presence of berry-producing plants attracts birds which eat a considerable number of larvae. Thus the increase in flora and particularly in introduction of berry producing plants like mulberry have both direct and indirect beneficial effects on the hygienic condition of the *shisham* forest. It is also an established fact that if the time of irrigation can so be manipulated as to produce an early flush of leaves, the defoliation vanishes. This is because early leaves which come out as a result of early watering become so thick in texture as to be inedible to the young larvae. Early watering is therefore directly beneficial for the health of the forest as far as *Plecoptera reflexa* attack goes and the indirect value in *Fomes lucidus* control is also great owing to proper soil moisture conditions and general vigour of the trees.

The striking part played by man as a factor of environment in influencing the cause of disease is seen from the example of *Trametes pini* on *kail*. Extensive areas of beautiful *kail* forests have been seriously affected in Kulu, Bashahr and Rawalpindi forests of the Punjab. Climatic and edaphic conditions are favourable for the species and trees have grown to very good size but the attack of *Trametes pini* has either completely ruined the trees for timber production or greatly reduced the outturn. Infection which takes place through above ground parts is entirely the responsibility of man who through lopping and torchwood cutting exposes the wood.

The disease is almost entirely confined to areas subject to lopping and torchwood cutting practices. The felling of diseased trees will not go a long way in decreasing the disease unless lopping and torchwood cutting are also stopped. Where lopping and torchwood cutting damage cannot be prevented such as in the uncontrolled village Forests, the other alternative is to increase the percentage of less susceptible trees like *deodar* and broad-leaved species. Where Government forests adjoin maltreated village forests, a belt of resistant species should separate the two to reduce chances of infection.

The above quoted examples are typical of the problems of forest hygiene in the Punjab and the experience in other parts of India is perhaps not dissimilar. It is obvious that on a superficial examination all these diseases appear to be purely mycological problems but close study shows that several silvicultural practices are also involved. The study of the disease in the ultimate form may be a mycological problem but evidence in most of the cases goes to show that the presence of certain adverse environmental factors is the primary cause of the disease. The initial causes of disease are usually not so obvious and this invariably leads one to think of the forest hygiene entirely in terms of mycology. This is however a mistaken policy. It will greatly help the cause of forest hygiene if everybody realised that the study of forest diseases is not a pure mycological matter but an understanding of the life of the forest as a whole. To maintain the forest in a satisfactory state of health it is essential to have greater co-ordination of mycology and silviculture. The need of this co-ordination increases still further when we see that the foresters under the stress of economic requirements are introducing exotic species or extending indigenous species to new areas. The health of these new crops depends directly on their suitability to the new environment. The future progress in the prevention and control of forest diseases will depend on the degree of co-operation between pathologists and silviculturists and the extent of their joint study of the factors of environment in relation to disease.

THE FLORA OF THE KAREWA SERIES OF KASHMIR AND ITS PHYTOGEOGRAPHICAL AFFINITIES WITH CHAPTERS ON THE METHODS USED IN IDENTIFICATION

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G/045/Is.—The Karewas of Kashmir, are extensive lacustrine and fluvio-glacial deposits of the Pleistocene age, occurring throughout the length and breadth of the valley. At lower elevations they lie in an undisturbed horizontal position in the form of low flat mounds. At higher altitudes, on the slopes of the adjoining Pir Panjal Range and the Main Himalayan mountains they are greatly disturbed and lie in a tilted position, often sloping away at different angles towards the valley floor. The Lower Karewa deposits towards the Pir Panjal side of the valley are richly fossiliferous and have yielded plant remains at Laredura, Dangarpur, Nagbal, Botapathri, Ningal Nullah, Gogajipathri, and Liddarmarg. ***These fossils were collected by Middlemiss, Jones,*** **De Terra, Wadia, Sahni, Stewart and the author.**

SUMMARY

The plant material, which comprises several thousand specimens of leaves (largely impressions), some fruits, seeds, cones, bits of woods and bark, has yielded a rich flora of 122 species of Angiosperms distributed in 64 genera and 6 species of Gymnosperms belonging to 5 different genera ; the Pteridophyta in the collections are represented by a single genus of the Filicales, and the Thallophyta are represented by more than eighty species of diatoms.

The flora is a heterogenous assemblage of terrestrial trees, shrubs, undershrubs, herbs (all hill types) and water plants ; the modern representatives of the fossil species occur today in the temperate montane or tropical forests of the Himalayas. The water plants form an important constituent of the modern Kashmir lakes and they have never been observed growing in lakes or ponds at an elevation higher than 5,200 ft., the present altitude of the Kashmir Valley. The terrestrial plants include some species which are growing at the present time at an altitude of 3-4,000 ft. or even at lower elevations ; a few ascend to very high altitudes, often merging in the alpine forests or directly abutting upon the treeless alpine meadows ; still others occur at intermediate altitudes.

The karewa flora includes both tropical and temperate species, there is also a subtropical element, but this, though it forms a small part of the flora as a whole, is fairly prominent in some localities.

There is a good deal of difference between the floras of the different localities. The species from Liddarmarg are growing at the present time in a sub-tropical or tropical climate, while all the species discovered from Ningal Nullah occur in regions with temperate conditions more or less similar to what we find today in the Kashmir Valley. At other localities (*Laredura, Dangarpur, and* Gogajipathri) there is mingling of the species some of which occur in temperate conditions and the other prefer tropical rain forests. This shows that the Kashmir Valley at some places *e.g.*, Liddarmarg, Laredura, etc., during the Pleistocene times enjoyed a tropical or *semitropical climate altogether* different from the present temperate conditions ; and at another place, namely Ningal Nullah, the climate was much cooler and temperate, essentially similar to what we find today in the Valley. The changes of climate indicated by the fossil plants are both interesting and significant.

There is a difference not only in species between the floras of the different localities, but there exists a sharp contrast between the altitudes at which the species are growing today in the Himalayan regions and the elevations at which they have been found in the fossil state. This furnishes a strong evidence in support of the theory of the Pleistocene uplift of the Himalayas, and explains the present tilted and disturbed position of the Karewa beds on the slopes of the Pir Panjal Range. This same event presumably brought about a great change in the climate of the Valley by cutting off from it the southern monsoon winds as well as heat of the Punjab plains. In consequence the climate became more

temperate in the latter part of the Pleistocene. The vegetation of the Valley also changed accordingly and the tropical element began to dwindle ; in course of time it disappeared almost completely, and we at the present time find purely temperate species in the vegetation of the Valley.

INTRODUCTION

In the year 1932, Dr. Hellmut de Terra, now of the Philadelphia Academy of Sciences, U. S. A. led the Yale North India Expedition to Kashmir and Ladakh to conduct geological and biological researches with a view to studying the glacial and inter-glacial cycle of changes during the great Pleistocene Ice Age in these regions. At the same time observations were made on the history of human cultures during the glacial cycle in N.W.India, and an attempt was made at a correlation of these cultures with those of Europe.

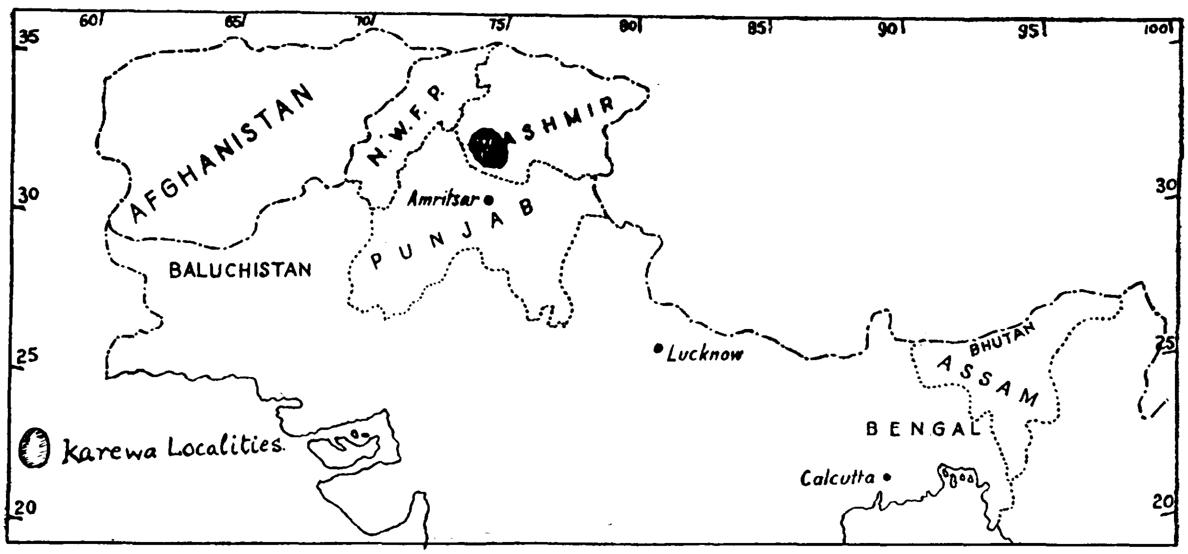
The studies were started on the younger deposits of Kashmir Valley, a great part of which is occupied by the fluvio-glacial and lacustrine deposits of the Pleistocene age. These deposits, which are believed to have been laid down during the various glacial and inter-glacial periods, not only occur at the present elevation of the Valley but they have been traced in a more or less continuous series both on the main Himalayan mountains and the Pir Panjal Range, which border it on north and south respectively.

During these investigations along the Pir Panjal side of the Valley, Dr. de Terra discovered some richly fossiliferous beds in Lower Karewa Formations (see Map, Text-fig. 1) which are the lake deposits of the First Inter-glacial Period (De Terra, de Chardin and Paterson, 1938, pp. 1-2). These deposits occur in the form of low flat mounds, in a more or less connected series of terraced platforms or isolated hillocks. The structure of these Karewa deposits is exposed in numerous ravines and hill sides both in the main Valley and on the slopes of the Pir Panjal Range. In the Valley which is on an average about 5,200 ft. above sea level, they lie in an undisturbed horizontal position, but on the high mountains of the Pir Panjal Range up to an altitude of 12,000 ft., or perhaps higher, they occur in a tilted position, sloping away from the mountains at various angles, the dip gradually decreasing towards the Valley. For descriptions of the geology of these deposits the reader is referred to the works of Middlemiss (1911, pp. 121-123), Sahni (1936, p. 13), Wadia (1938, pp. 194-195; 1939, pp. 437-438) and de Terra and Paterson (1939).

A collection of about 800 specimens was made by de Terra from three different localities on the Kashmir side of the Pir Panjal. Two of these localities were already long known to yield plant material together with fresh-water shells and some fish scales. As early as 1859 Godwin Austen pointed out the occurrence of plant fossils and shells in beds at Gogajipathri (8,800 ft. altitude ; latitude 33° 51′ ; longitude 74° 41′). In 1910 C. S. Middlemiss (1941, pp. 120, 121) found plant fossils at this place and also collected about 200 specimens from Liddarmarg (10,600 ft. altitude ; 33° 48′ ; longitude 74° 39′), a locality about 40 miles from Gogajipathri. From the descriptions of the localities given by Middlemiss and de Terra it seems that the spots where de Terra collected his material in the neighbourhood of Liddarmarg, were different from those of Middlemiss.

In the summer of 1932 de Terra, at the suggestion of Professor B. Sahni entrusted the investigation of his first collection, comprising nearly 800 specimens to the late Dr. S. K. Mukerji, Reader in Botany at the Lucknow University ; this material, which was presented by de Terra to the University, was sent to Lucknow early in the year 1933, and as originally planned, the work would have been finished long ago, had it not been cut short in its early stages by the death of Dr. Mukerji (see Sahni, 1936, p. 12).

Three years later, in 1935, when de Terra re-visited Kashmir to complete his researches, he made further collections from the Karewas at two different places, both of which lay in the Baramulla Gulmarg region. On this second expedition he was assisted by Dr. R.R. Stewart, Principal of the Gordon College, Rawalpindi and Mr. N. K. N. Aiyengar of the Geological Survey of India. A collection of about 700 specimens of fossil plants, together with some animal fossils was made on this occasion from two different localities, Laredura and Ningal Nullah newly discovered on this excursion. It was agreed to leave this material in the Gordon College for investigation by Dr. Stewart.



Text-fig. 1. An outline Map of Northern India, showing the geographical position of the plant-bearing region in Kashmir. The places (Lucknow and Amritsar) where the Karewa Flora has been investigated are also indicated for general interest.

(Based on the Map of India published in "Palaeobotany in India, III, **Journ. Ind. Bot. Soc. Vol. 21, 1942**).

After the death of Dr. S. K. Mukerji Prof. Sahni sent to Dr. Stewart the material on which Dr. Mukerji had been working till the time of his premature death in August 1934. In the summer of 1936 two further collections of about 600 specimens each were made by Dr. Stewart himself from two new spots lying near each other in the Upper Ningal Valley (Lat. 34° 4′; long. 74° 19′) at an altitude of 9,000 ft. These localities are referred to in the present work as Loc. " N ".

In 1947, the Principal of the Gordon College, Rawalpindi offered a studentship to the author to work out the material that had accumulated in his laboratory since 1932. The author carried out the preliminary identifications of these specimens under Dr. Stewart's guidance in the Gordon College Herbarium, where a large representative collection of the living plants from all over the Himalayas was available for comparison with the fossil material. A few months later, in 1938, the author was granted the privilege of working for the first time in Prof. Sahni's laboratory, at Lucknow, since when the work has been carried on under his direct guidance. A little later, Prof. Sahni also entrusted to the author his own collections, which he had made from over a dozen different places in the Baramulla-Gulmarg region of the Valley, during excursions in 1934, 1936 and 1938. Since then further additions to the material have been made by the author himself year after year. The bulk of the material has thus steadily increased and the entire collection, which forms the basis of a number of papers comprises as many as 15,000 specimens. During a period of about six months in the summer of 1939, when the author was temporarily employed as Lecturer in Chemistry at St. Joseph College, Baramulla, several trips were made to the fossiliferous localities lying in the Baramulla-Gulmarg region. On some of these excursions the author was accompanied by friends and students. A large area was surveyed, and thousands of specimens were unearthed from many places, and examined in the field. A large representative collection of some few thousand specimens was accumulated at Baramulla. About 900 nicely preserved specimens were selected from the lot for a detailed study and the rest were deposited in the Science Department of the College after a preliminary examination. These specimens, I later on learnt, were lost when the Science Laboratory of the College caught fire in 1940.

Three more collections were made by the author in 1940, 1941 and 1942 from Laredura, Nagbal, Dangarpur, Ningal Nullah, and Botapathri when research grants were made available to him from the University of the Punjab. This material, which was selected at the spot, comprises about 2,000 specimens.

A further lot of about 200 specimens collected by C. S. Middlemiss in 1910 was kindly made available to me on loan for study by the Director, Geological Survey of India.

In addition to this material a few small collections consisting of over a dozen specimens each were presented to me by friends who had seen me collecting in the field on one occasion or another. The chief of these was a gift of 32 specimens from Mr. S. S. Gergon, of the Kashmir Forest Service, who had picked them up from a spot in Ningal Nullah in 1939. Another noteworthy collection was one made by *Prof. T. R. Chadha*, Messrs. Prem Bhasin, and Ram Nath of D. A. V. College, Rawalpindi, from a few spots known to me in the vicinity of the village Laredura. Prof. R. Saiup of the D. A. V. College, Rawalpindi brought me a few specimens from Botapathri when he visited Kashmir in 1940. Father Luif of the St. Joseph College also found a few badly preserved fossil leaves at a spot a few furlongs from the College at Baramulla.

From what has been said above it will be seen that it has been possible for me to have access to all the known collections of fossil plants so far made from the Lower Karewa deposits of the Kashmir.

ACKNOWLEDGMENTS

This work has been conducted under the supervision of Prof. B. Sahni, Sc. D., F. R. S. to whom I am highly indebted for his ready and invaluable guidance, helpful criticism and generous help given to me during the course of this investigation. His personal interest in the work has been a great source of inspiration and encouragement, which stimulated me for higher aspirations in life; for all this and many more favours I wish to express my sincerest gratitude. I am equally grateful to my old teacher Principal R. R. Stewart

for initiating me into this subject and giving me all possible help in the systematic part of this work done at the Gordon College, Rawalpindi, under the tenure of a studentship from that College. I must thank him and Mr. Mohindar Nath for sending me a lot of living material from time to time for comparison with the fossils at Lucknow. My thanks are due to the Vice-Chancellor of the Punjab University and Principal Jodh Singh of the Khalsa College, Amritsar for the award of a research scholarship for three years from the University and from the Khalsa College to carry on the work at Lucknow. The help given by the Lucknow University in the award of a Research Fellowship is also gratefully acknowledged.

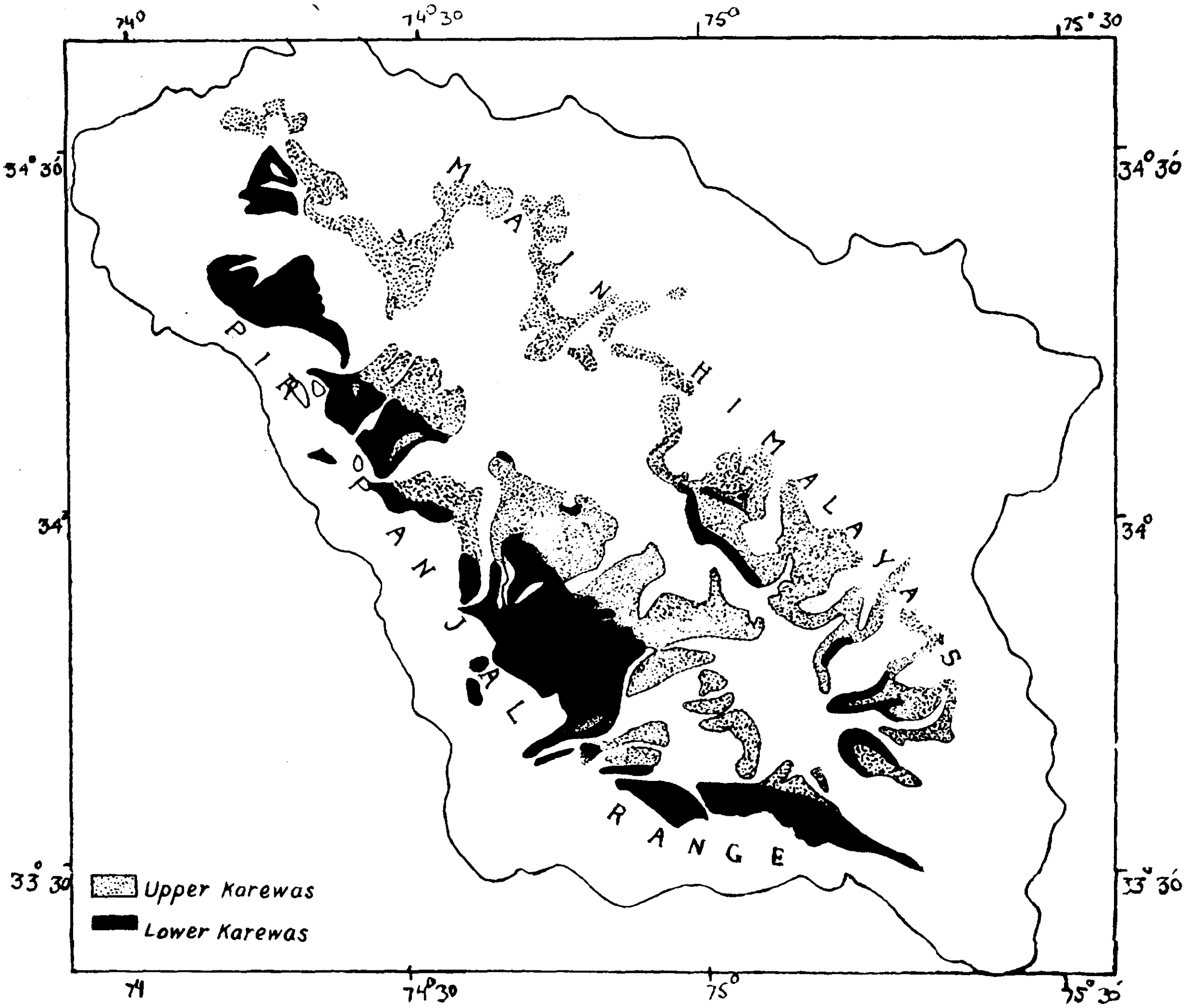
To the Director, Geological Survey of India, I am grateful for the loan of Middlemiss's collections and for the photographs of some of the specimens. His kind letters to the Curator, Royal Botanic Gardens, Sibpur, and the Forest Botanist, Forest Research Institute, Dehra Dun, brought me many good specimens of living plants for comparison with the fossils and for this I am thankful to all those concerned. I am particularly grateful to the Forest Botanist, Dr. N. L. Bor, I. F. S. for his help, advice and interest in my work. I wish to acknowledge with thanks the co-operation, kind help and all possible facilities rendered by the Kashmir State Forest Service particularly Thakur Harnam Singh D. F. O. during my collection trips in 1939, 1940, 1941 and 1942. Prof. B. K. Roy of Khalsa College kindly looked through a part of this paper and made a few corrections, for which I am very grateful to him. It is my pleasant duty also to thank Mr. K. N. Kaul, Dr. K. Jacob and Dr. R. V. Sitholey, to the first two for their lessons in photography and to the third for rendering me help in illustrating my several papers. Finally I am glad to acknowledge the great assistance rendered by Mr. V. S. Sharma in coping with the large amount of photographic work entailed by this investigation.

DESCRIPTION OF THE KAREWAS

Any detailed geographical or geological description of the Karewa Formations is beyond the scope of the present work. Nearly every geologist who has visited this region has been tempted to indulge in the fascinating study of these deposits. It would not be worthwhile to enumerate here all those references to the literature, that are available on the subject, but a brief mention of some of the more important works would suffice for the present paper. A fairly complete description of the geography and geology of the Karewas is furnished by the writings of some of the earlier geologists including Godwin Austen (1859, pp.221-229), Drew (1875, pp.167-170 and pp.207-212) and Lydekker (1878, pp. 31-34). Among the more recent works that have appeared during the last twenty years, are papers by Middlemiss (1911, pp. 120-124 and see Middlemiss in Hayden, 1914, p.38), Sahni (1936, pp. 10-16) Wadia (1938, pp. 191-195; 1939, pp. 437-438) and de Terra and Paterson (1939). A brief summary of the above works is attempted in the following few pages with a view to facilitating a clear understanding of some of the salient features of the geology of the Karewas.

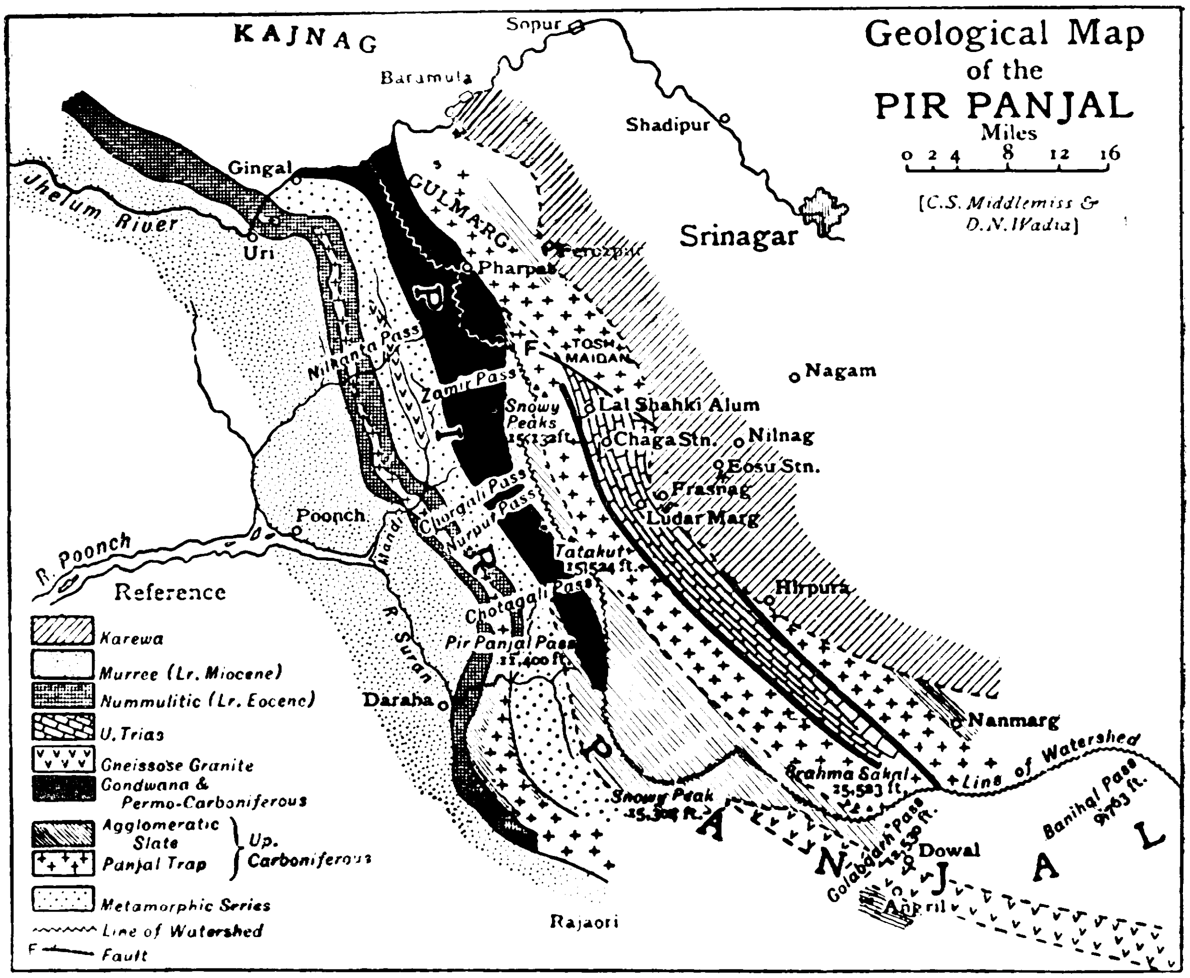
The Karewas, as already stated, are a series of fluvio-glacial and lacustrine deposits of Pleistocene age, occurring as low flat mounds in the Valley of Kashmir. The word "Karewa" has been used for these mounds by the Kashmiris (Drew, 1875, p. 167). These tablelands occupy almost half the area of the Kashmir Valley, which runs for a length of about 84 miles lying between the parallel running mountain ranges of the Central Himalayas on the north-east and the Pir Panjal Range on the south-west and attains a maximum width of 25 miles in its broadest part.

The Karewas Series of deposits is divided into the Upper and Lower Karewas. The accompanying map of the Kashmir Valley (Text fig. 2) taken from the memoir of de Terra and Paterson (1939, Pl.55) gives the geographical divisions of the Upper and Lower Karewa deposits. All the plant-bearing outcrops from where the material has been collected lie in the Lower Karewa deposits. It was Lydekker (1878), who first gave the name "Lower Karewa lake beds" to the lacustrine deposits occurring towards Pir Panjal side of the Valley. De Terra (see de Terra and Paterson, 1939, p.109), while describing these beds, writes: "The lower Karewa lake beds can be defined as a fluvio-lacustrine formation, which is uncomformably overlain by glacio-fluvial outwash deposits of the second ice advance (Karewa



Text-fig. 2. An outline Map of Kashmir, showing the relative positions of the Lower Karewa deposits (jet black areas) which have yielded fossil plants, and the Upper Karewa deposits (stippled areas) occurring both on the Pir Panjal Range, and the Main Himalayan mountains; the paucity of the Lower Karewas on the Main Himalayas is evident.

(After De Terra and Paterson, 1939, pl. 55). With Permission.



Text-fig. 3. Geological Map of the Pir Panjal (based on the works of C. S. Middlemiss and D. N. Wadia) showing the stratigraphy of the Karewa beds. The fossiliferous localities 1, 2, 3, 4, 5 (marked by the author) are Laredura, Dangarpur, Ningal Nullah, Gogajipathri and Liddarmarg.

(From **Rec. Geol. Surv. Ind.**, Vol. XLI, pt. 2). With permission.

gravel) and underlain by either bedrocks or fans older than the first inter-glacial stage."

These Lower Karewas, lying on the south-west side of the Valley adjoining the Pir Panjal are exposed over an area 8 to 16 miles wide and about fifty miles long extending from Baramulla to Shopyan according to Wadia (1939, p. 437), and about 80 miles long according to recent work of de Terra (see De Terra and Paterson 1939, p. 109). They occupy a much greater area than those which lie towards the northern side of the Valley. The Lower Karewa deposits towards the Pir Panjal occur in scattered patches from an altitude of 5,300 ft. in the Valley to as high as 11,000 ft. on the neighbouring mountains (see Middlemiss in Hayden, 1914, p. 38). Their presence on the Central Himalayan Ranges on the northern side of the Valley is restricted to much lower altitudes than those on the Pir Panjal side. Moreover the Lower Karewas on the Pir Panjal side are in a much better state of preservation and are exposed in clear sections along natural ravines and banks of hill streams, which have greatly eroded these deposits and cut them into isolated flat-topped hills and terraced blocks. These deposits are rich in fossils and all the plant-remains have been collected from localities lying at various altitudes in this region. This is another reason why these deposits occurring on this side of the Valley have been studied by geologists in much greater detail than those lying on the Main Himalayan slopes or elsewhere in this region.

The geological position of the Karewas with respect to the older rocks of the Pir Panjal is brought out clearly by the geological map (Text fig. 3) based on the works of Middlemiss and Wadia. The thickness of the Karewas Formations as a whole according to the estimates of Middlemiss (see Middlemiss in Hayden, 1914, p. 38) is 3,000 ft., but the recent works of de Terra, 1935, p. 1 and Wadia (1928, p.195) show it to be between 5,000 and 5,500 ft. respectively. These fossiliferous beds, which belong to the Lower Karewa Series, are in their upper part considered to be composed of lake sediments belonging to the First Inter-glacial Period. Some deposits of the Second Inter-glacial Period too might have contributed a little to their thickness. The Lower Karewas may from below be traced into the Pliocene but the boundary is not yet definitely located. Most of the fossiliferous localities so far discovered lie in the Baramulla-Gulmarg region between the altitudes of 5,000 ft. and 10,000 ft. The beds lying at the lower altitudes of 5,500 to 6,500 ft. near about Baramulla and Laredura are very irregularly placed and cut into deep fissures at some places. They are for the most part bare of shrubby or tree vegetation except near Laredura and Dangarpur, where small trees of *Cedrus Deodara* Loud., *Aesculus indica* Colebr., *Juglans regia* L., species of *Salix* and a fairly thick undergrowth of *Parrotia Jacquemontiana* Dcne and *Rosa Webbiana* Wall. are flourishing. This part of the Karewas underwent a great destructive change by the severe earthquake of 30th May 1885, which caused heavy loss of life and property (Jones, 1885, p. 226). The whole village of Laredura, which was probably much bigger than it is today, was completely destroyed by the slipping down of a thick stratum of soft clay which was a part of the Karewa deposits.

The other Lower Karewas, which have yielded fossils, lie on the other side of a high mountain, which borders the villages of Laredura and Dangarpur on the south. Here they occur in the form of wide grassy meadows in the Upper Ningal Valley near the villge of Botapathri. The beds here and near the village of Hajabal are composed of varved clay, which is rich in plant-fossils. A careful search in the Baramulla-Gulmarg region must bring to light many more plant bearing outcrops, which would provide rich material for the palaeobotanists.

Small patches of forested Lower Karewa beds lie in the Gulmarg-Liddarmarg region also, and they have yielded plant fossils from the neighbourhood of Gogajipathri and Liddarmarg at the altitude of 8,800 ft. and 10,600 ft. respectively. The position of these deposits in this region is very much disturbed and the beds lie tilting and sloping towards the Valley. These Lower Karewas of the Pir Panjal have been traced in an almost continuous series down to the Valley where they lie relatively undisturbed in an almost horizontal position.

PLANT-BEARING OUTCROPS

The plant-bearing beds of the Lower Karewas are composed of a fine grained, soft clay, which is of a somewhat blackish grey, bluish, and yellowish-gray colour at different places. The clay is generally well-bedded, and splits regularly, but at some localities being sufficiently hard, it cracks irregularly when split to expose fossils. On the basis of toughness and the manner

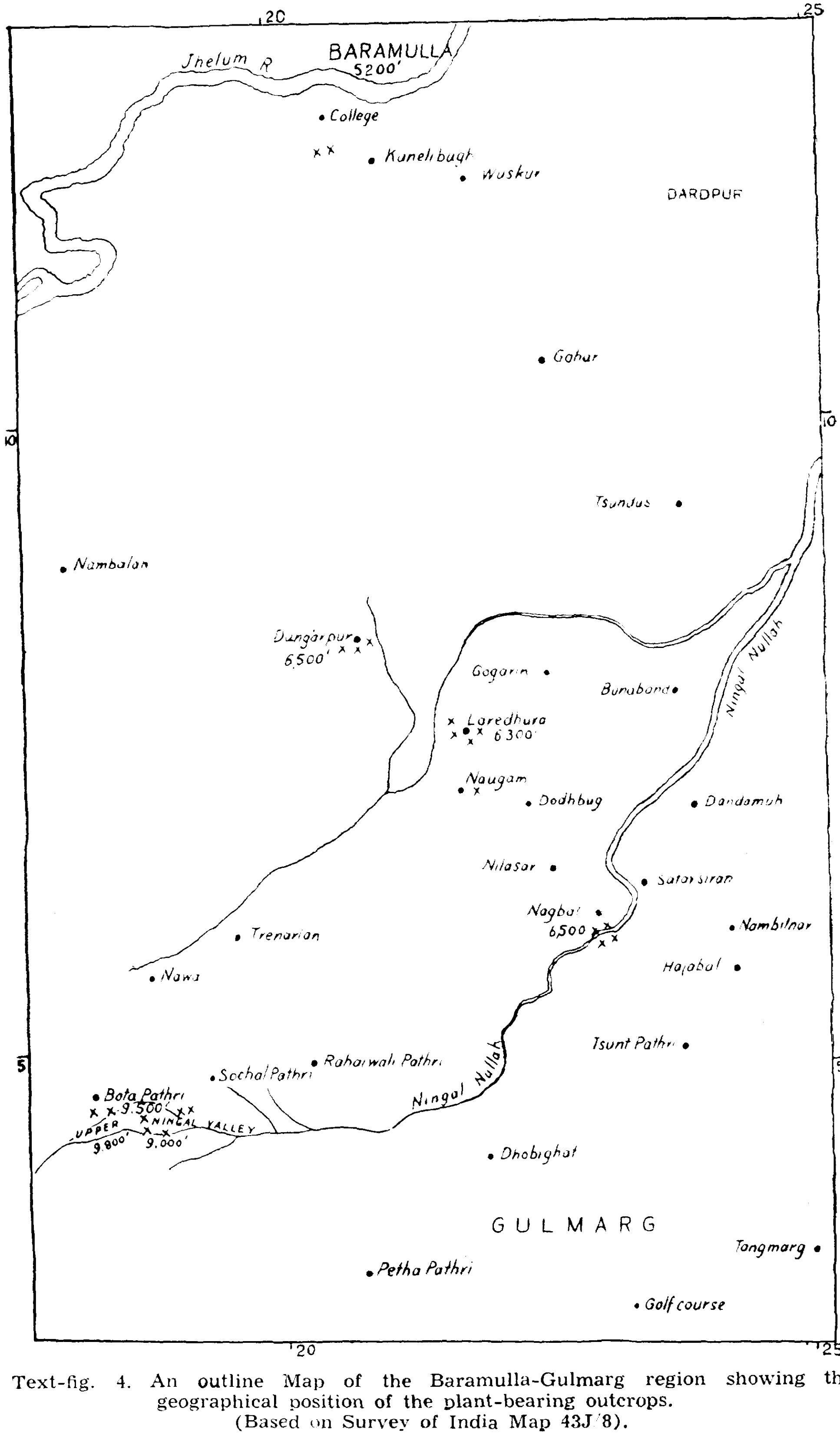
in which the clays are bedded, the fossiliferous beds at various localities may be broadly classed under two main groups. The first group includes the beds which are exposed at Laredura, Dangarpur, Botapathri, Nagbal, Gogajipathri, and Liddarmarg; the grey clay at these places has a blackish tinge and is very hard and compactly set into thick layers. For collection of fossils from these places large blocks of clay have to be scooped out with a pick-axe and removed to a convenient place for chopping into smaller pieces, which can be easily handled and split further to expose fossils. The splitting is best done with a stout knife with a wide blade; a chisel does not seem to serve the purpose well as it is too narrow and blunt for splitting thin layers of soft clay. The smaller leaves split out perfect, but most of the bigger leaves get broken due to irregular cleavages in the clay itself. A few large leaves have been procured unbroken or fairly complete by carefully splitting the blocks of clay.

The beds belonging to the second category are composed of slightly coarse-grained clays, which are mostly pale yellow, but also have a bluish-grey colour at some places. These clays are made up of very thin layers composed of coarse and fine sediments alternating with each other. These thin layers technically known as "varves" are characteristic of glaciated regions. Such beds composed of "varved" clays are exposed at several places in the Upper Ningal Valley and at Hajabal. The collection of fossils from these places is a difficult task, because the soft clay crumbles into worthless pieces under a slight pressure.

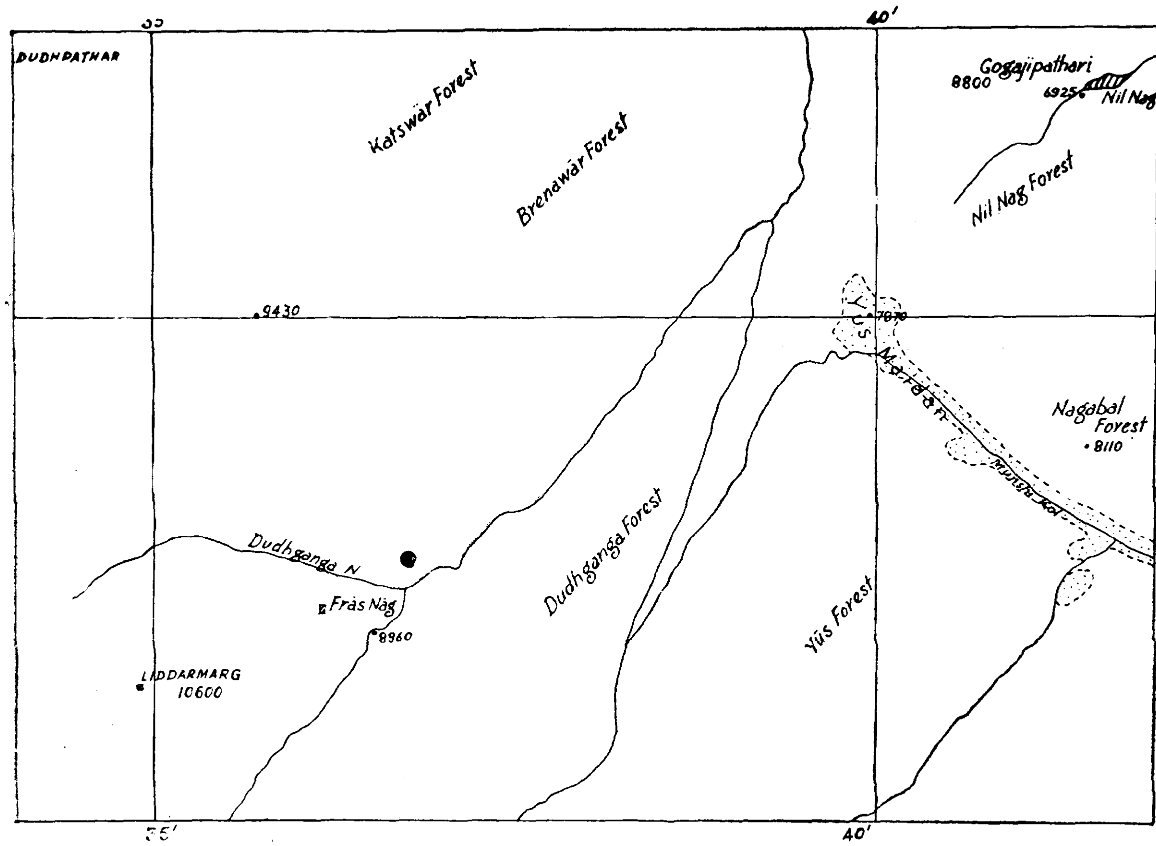
The following table shows in a birds-eye view the fossiliferous localities, their altitude, latitude, longitude, collectors of fossils and names of people who discovered them; their geographical distribution is shown in the accompanying maps (Text figs. 4 & 5) of the Kashmir Valley.

TABLE OF LOCALITIES

Loc. No.	Loc. Name.	Location.	Altitude.	Lat. & Long.	Collectors.	By whom discovered.	References.
1	Loc. L. spot No. 1	Laredura	6,000 ft.	34°7′ N.; 74°21′ E.	G. S. Puri	G. S. Puri	Puri, 1942
2	„ „ spot No. 2	„	„	„	„	„	„
3	„ „ spot No. 3	„	„	„	„	„	„
4	„ „ spot No. 4	„	„	„	„	„	„
5	„ „ spot No. 5	„	„	„	„	„	
6	*Trapa*-bearing Loc.	„	„	„	„	„	„
7	De Terra's Loc.	„	6,280 ft.	„	De Terra and Stewart.	B. Sahni	De Terra and Paterson, 1939
8	Loc. D.	Dangarpur	6,500 ft.	34°8′ N.; 74°20′ E.	G. S. Puri	G. S. Puri	Puri, 1942.
9	Loc. D.	„	„	„	„	„	„
10	Loc. 1 D. De Terra's Loc.	„	6,300 ft.	„	De Terra	De Terra	
11	Loc. 2 D Sahni's Loc.	„	6,500 ft.	„	B. Sahni	B. Sahni	Sahni, 1936.
12	„	„	„	„	„	„	„
13	.. ..	Nagbal.	6,500 ft.	34°6′ N.; 74°23′ E.	G. S. Puri.	G. S. Puri.	Puri, 1942.
14	Loc. N.	Ningal-Nullah	9,500 ft.	34°4′ N.; 74°19′ E.	R. R. Stewart.	R. R. Stewart.	De Terra and Paterson, 1939.
15	Loc. 2 N.	„	„	„	G. S. Puri.	G. S. Puri.	Puri, 1942.
16	Loc. 1 N.	„	„	„	„	„	„
17	Loc. 3 N.	„	„	„	„	„	„



Text-fig. 4. An outline Map of the Baramulla-Gulmarg region showing the geographical position of the plant-bearing outcrops.
(Based on Survey of India Map 43J/8).



Text-fig. 5. An outline Map of the Gogajipathri-Liddarmarg region showing geographical position of the plant-bearing localities. (Based on Survey of India Map 43J/8).

TABLE OF LOCALITIES—(oncluded.)

Loc. No.	Loc. Name	Location	Altitude	Lat. & Long.	Collectors	By whom discovered.	References.
18	Loc. B.	Botapathri.	9,500 ft.	34°4 S N.: 74°19E.	R. Sarup.	R. Sarup.	Puri, 1942.
19	Loc. 1 B.	,,	,,	,,	B. Sahni.	B. Sahni.	Sahni, 1936.
20	Loc. 2 G.	Gogajipathri	8,8000 ft.	33°51'N.; 74°41 E.	De Terra	Godwin Austen and De Terra	Middlemiss, 1911. De Terra and Paterson, 1939.
21	K 14/948 and K 14/951, K 14/952, K 14/953.	Liddarmarg	10,600 ft.	33°48'N'; 74°39'F.'	Middlemiss.	Middlemiss.	Middlemiss, 1911.
22	Loc. 3 L.	,,	,,	,,	De Terra	De Terra	De Terra and Paterson, 1939.

LAREDURA

Locality L.—Laredura, 6,000 ft. (lat. 34°7'; long. 74°21'); about seven and a half miles south-west of the town of Baramulla, and about half a mile down from the footpath that leads to Gulmarg, there is an extensive strata of the Karewa deposits which, when viewed from the footpath, are seen in the form of small bare patches peeping out from a thick growth of small trees of *Cedrus Deodara* Loud. (Pl. 1, Fig. 1). This place is situated at a distance of about a mile and a half from the village of Laredura, the only village near the strata. These deposits furnished plant-material at five different places (marked with arrows in the photograph, Pl. 1, Fig. 1); all these places except one (marked 5 on the right-hand side in the same photograph) yielded badly preserved specimens. This spot was called No. 5 in the excursion and a few specimens collected from this stratum were got only from this spot.

Another similar outcrop was found about two furlongs north-east of the main huts of the village of Laredura. This stratum, which runs for a length of about 300 feet facing the village on its steep side turned out to be richly fossiliferous at four different spots. It stood in the form of a steep cliff about a hundred feet high from the main fields below. It is fossiliferous only towards its upper limit, the digging at the lower parts did not unearth any fossils. The photograph (Pl. 1, Fig. 2) shows a view of this exposure; the numbers 1, 2 and 3 point out the three spots and the 4th spot (not seen in the photograph) lies on the right-hand side of spot No. 1. The arrow towards the bottom of the picture points to two men sitting at the base of the cliff. All the four spots, as is seen from the photograph, lie within short distances horizontally and vertically of one another. The occurrence of fossil plants in the four spots, so close to one another in the stratum, leads one to think that it may be fossiliferous along its entire length and digging at other places might be rewarded with plenty of well preserved material.

(1) *Spot No.* 1.—The photograph (Pl. 2, Fig. 3) shows a close view of this spot. The fossils are collected *in situ* from thick layers, which are compactly set and hard. This spot furnished the largest number of specimens, most of which were well-preserved impressions of leaves of terrestrial trees and shrubs. In addition to yielding a large number of leaves of many different species, it provided some good specimens of samaras of maple, two almost complete leaves of *Acer* sp. and a cupule of Oak. The *Acer* leaves do not seem to match any species of *Acer* represented in the present-day floras of the Himalayas.

(2), (3) *Spots Nos.* 2 *and* 3.—These lie on the left-hand side of spot No. 1 (see photo, Pl. 1, Fig. 2); they are comparatively poor

in fossil specimens, but the leaves collected are well preserved. One noteworthy specimen, which was yielded by spot No. 3, was a complete leaf and its counterpart, referable to *Corylus ferox* Wall., the modern distribution of which is restricted to the Central Himalayan regions.

(4) *Spot No. 4.*—Of all the spots in this region this is the poorest in fossils. Except for a few good leaves dug out from the surface, the material obtained from the deeper layers was wet and badly preserved.

It may be interesting to note that all the spots in this stratum, which lies at a higher level from the main paddy fields, yielded leaves, fruits etc. only of terrestrial trees and shrubs. As many as 70 per cent of the leaves belong to three species of oak, *Quercus semecarpifolia*, Q. *Ilex* and *Q. dilatata*. Not a single *Trapa* fruit or any other water plant was found in them.

The leaves in this locality occur in a fine grained blackish-grey clay in layers of 4 to 6 inches thick. The layers break readily along the bedding plane to yield fossils. The material when freshly cut was soft and wet and had to be dried for some time in the shade before packing. The venation of wet leaves gets disfigured if the latter are wrapped wet.

(5) The locality has already been referred to on page 20.

(6) *Trapa-bearing locality.*—At a distance of about half a furlong towards the village from this stratum, there is another outcrop exposed along a narrow stream (Pl. 2, Fig. 4). The beds here lie at a lower level but the clays are apparently of the same colour and texture. By digging at several spots in these beds along the stream for a length of about 200 ft. fruits of two species of *Trapa* were discovered in thousands. It seems that the whole thickness of the bed which is vertically exposed for 8 to 10 ft., is probably rich in these fruits. The arrows in the photograph (Pl. 2, Fig. 4) show the spots which yielded fossil fruits along the vertical thickness of the beds. A long and careful search made by myself alone and with a party of friends and students on several excursions to this region, failed to unearth even a single leaf fragment of any terrestrial plant. This observation seemed particularly interesting in view of the fact that the other two strata mentioned above did not yield remains of any water plants.

(7) *De Terra's locality.*—Loc. L. H. de Terra and Dr. Stewart made a large collection of fossil plants, which were lent to the author for study, from some locality in this area. I could not find the spot, hence the following description of this locality is quoted from "The Memoir," by de Terra and Paterson (1939, p. 113).

"At Laredura a rich plant locality was found on an escarpment 400 yards east of the hamlet. The leaves are embedded in a tough laminated clay, which upon drying, becomes shaly and brittle, the perfect preservation of the nervature and the delicate bedding of the vegetable matter indicates deposition in very quiet water. The altitude of this plant bed is 6,280 ft."

DANGARPUR

(8) *Locality D.*—Dangarpur at 6,500 ft. (lat. 34° 8′; long. 74° 20′). About a mile and a half to the south of the main huts of Laredura village some deposits composed apparently of the same kind of clay as in Laredura were seen exposed along a stream and lying in the fields near the village of Dangarpur (Pl. 3, Fig. 5). The beds along the bank of stream (marked by arrows in Pl. 3, Fig. 5) were found to be rich in fruits of *Trapa* while those in the fields (also marked by arrows), (*spot* 9) which were tilled at the time of my visit, contained an abundance of badly preserved leaves of the same species of *Quercus*, that was found in abundance at Laredura. I was told by the villagers that farmers frequently uncover such leaves (the villagers call them "nakshas" (*i.e.*, patterns on clay) from many fields in this area when they till them for sowing maize and *Linum* crops. I visited a few such fields lying close by the one shown in the photograph (Pl. 3, Fig. 5), but found in the same kind of blackish-grey clay as is found at Laredura badly preserved leaves not worth collecting.

(10) *De Terra's locality.*—Loc. 1 D. H. de Terra collected about 200 specimens of fossils from some place in the neighbourhood of the village. This collection, which was kindly loaned to the author for study by Prof. Sahni contains badly preserved leaves.

One noteworthy specimen from this material was a well preserved, almost complete leaf of *Hamiltonia suaveolens*, which is reported only from this locality. The following description of the plant-bearing outcrop is taken from a letter dated the 16th September 1933 from Dr. H. de Terra to the late Dr. S. K. Mukerji :

("The beds are) due 5 miles of Baramulla, one furlong east of Dangarpur village, (lying at a) steep cliff at 6,300 ft. above sea level. (They are) made up of light-grey clay with plant layers, which dipped 30 degrees north with east-west strike." (The words in brackets are added by me).

(11) and (12) *Prof. Sahni's locality.*—Several hundred fruits of *Trapa* embedded in about 50 to 60 big blocks of clay were collected by Prof. Sahni from several spots in this region.

NAGBAL

(13) *Locality Nagbal.*—Altitude 6,500 ft. (lat. 34° 6′ ; long. 74° 23′). Quite a few well preserved leaves of *Quercus*, two specimens of *Ulmus* and many fruits of *Trapa* together with some more badly preserved leaves referable to other modern specie weres discovered from low level beds, which were exposed along the right bank of the Ningal Nullah, flowing past the village Nagbal at an altitude of about 6,500 ft. The beds which are at a distance of about 8 miles from Laredura, can be reached from there by a footpath which, passing through Naugam and this place leads to Tangmarg. The Nullah has cut its way through the fossiliferous beds, which have mostly been washed away by its water. Touching the water on its right bank a small stretch of a stratum is exposed in a 4 to 5 feet thick vertical section. This place abounds in the remains of *Trapa* fruits and contains leaves of terrestrial plants as well. The nature of bedding of the clay is apparently similar to that found in the Laredura and Dangarpur deposits. The clays were very wet.

A few more similar outcrops were found along both sides of the Nullah while going downstream; these deposits also contained badly preserved plant-material, not worth collecting.

A few huge mounds of clay were witnessed in the vicinity of the village where some fragmentary plant-material was observed in a coarse grained clay. I was told by the Nambardar of the village that one Mr. Soni had made borings at two places in 1935. I visited those spots and found some pieces of lignite and black charred clay on the surface. A long tree was later shown to me by a coolie, who told me that this was unearthed by Mr. Soni's party. Much reliance may not be placed on the statements of the villagers, who cannot appreciate these things more than looking at us, who go about fossil hunting, a bit curiously. The huge log lying on the surface may be lignite ; as Middlemiss (1923) has discovered fields of lignite coal occurring at the depth of only a few feet from the surface in the Karewa beds at several places in this region.

NINGAL NULLAH

(14) *Locality N.*—Ningal Nullah at 9,500 ft. (lat. 34° 4′ ; long. 74° 19′). About 5 miles on the south of Dangarpur village across the high mountain, that borders it on this side, there is a wide grassy plain, which is in the form of a low terraced mound resembling in appearance the famous golf courses of Gulmarg. This place can also be reached from Gulmarg by a footpath which passes by the Dhobie Ghat and leads to the bridge at the Ningal Nullah (Pl. 4, Fig. 7), where people often go from Gulmarg for one day picnics. These grassy meadows lie at a distance of only about two furlongs from the bridge.

The fossiliferous beds are covered by a green mat of grass, where the shepherds of the nearby huts bring their cattle for grazing ; the beds are exposed in vertical cliffs at many places along the small streams that traverse the area and at three spots by the side of the main footpath leading to Gulmarg. The photograph shown in Pl. 4, Fig. 8, which was kindly given to me by Dr. Stewart, shows the three spots (marked by arrows) from where he collected a large number of well preserved plant fossils in 1936. This place, in addition to furnishing leaves of such forest trees as willows, poplars, pears, cherries, walnuts, alders, *Rhamnus* sp. etc. yielded a nice leaf fragment of *Nelumbo nucifera* Gäertn. the modern representatives of which grow

abundantly in the fresh water lakes of the Valley at 5,200 ft. The clay here is thinly bedded with very fine and thin layers, which are composed of alternating coarse and fine sediments resembling the "varved" clays. The beds here are composed of much weathered clays, which are of a pale yellow colour.

(15) *Author's locality.*—Loc. 2 N. A few hundred feet away from this locality, the author found a similar kind of fossil flora embedded in "varved" clays lying at almost the same elevation. The photograph (Pl. 1, Fig. 8) shows the three spots which furnished the fossils.

(16) *Locality* 1 *N.*—At a distance of about half a mile from the above mentioned localities towards the Gulmarg side and a furlong away from the bridge (see Pl. 5, Fig. 7) another richly fossiliferous locality was found by the author. The colour and texture of the clay is exactly of the same kind as in other localities on the meadow. The photograph (Pl. 3, Fig. 6) shows the beddings of the clay in the stratum which yielded fossils. Towards the upper part of the photograph there are seen inter-bedded with the plant-bearing clays a number of boulders, which probably form part of a glacial moraine. This place furnished, besides other several good specimens of leaves and samaras of *Acer* sp. some well-preserved leaf fragments of *Aesculus indica* Colebr., a nice barberry leaf, and a few leaves of *Inula cappa* D. C.

(17) One more spot (Pl. 5, Fig. 10) in the meadow lying midway between the localities N and Loc. 1 N was found to contain some badly preserved fossil leaves.

The specimens gathered from these localities lying near Ningal Nullah are well-preserved leaf impressions; all the specimens excepting a leaf of *Pyrus Malus* Linn., two leaves of *Inula*, a barberry and a few other small leaves, were broken. It is very difficult to split out complete leaves because of the clay being soft, brittle and thinly bedded. The specimens suffered a great damage in transportation and a worthless heap of broken pieces was all that was left of many good specimens on reaching the laboratory.

It is interesting to note that in all the localities investigated in these thinly bedded clays, the leaves of *Quercus* were conspicuous by their absence. With a very few exceptions the fossil flora discovered here is composed of such broad-leaved trees as walnuts, maples, cherries, poplars, willows and horse chestnuts, etc.

BOTAPATHRI.

(18) *Locality B.*—Botapathri at 9,500 ft. (lat. 34° 48'; long. 74° 19'). Prof. R. Sarup of the D. A. V. College, Rawalpindi, picked up from a stream bed near the village of Botapathri a few blocks of clay which on splitting yielded some specimens of *Q. glauca* Thunb. and *Q. incana* Roxb. I could not visit this locality on any occasion hence nothing more is known about it.

(19) *Prof. Sahni's locality.*—Prof. Sahni collected from this place several hundred specimens of *Trapa* fruits and some leaves, one of which was sufficiently well preserved to be specifically determined as *Q. incana* Roxb.

The occurrence of oaks and waternuts in this locality is interesting in the light of the fact that no oaks or waternuts were discovered from the other localities in the Ningal Nullah. The clay from this locality resembles those from Laredura, Dangarpur and Nagbal and the flora resembles that discovered at Liddarmarg, a locality which will presently be described.

It is likely that a further search in this area will bring to light many more fossiliferous localities.

GOGAJIPATHRI

(20) *Locality 2 G.*—Gogajipathri at 8,800 ft. (lat. 33° 51'; long. 74° 41'). H. de Terra collected here a large number of fossils belonging to the same species that are found in Dangarpur and Laredura. This material excepting a few good leaves, *Pyrus lanata* D. Don., *Ulmus campestris* Linn. and *Rhus cotinus* Linn., mainly comprises badly preserved leaves of the three species of *Quercus*. However, some other species are also represented. The clays at this locality are as tough and dark as those exposed at Dangarpur and their bedding too is of the same nature.

The following brief information about this locality is taken from a letter dated New Haven, Connecticut, the 16th Sept. 1933 from Dr. H. de Terra to the late Dr. S. K. Mukerji (which Prof. Sahni kindly gave to me).

"*Locality* 2.—Topographic sheet 4319: C 2. $1\frac{1}{4}$ furlongs north of upper houses of Gogajipathri village. Plant layers and yellow sandy shales intercalated with grey clay.

LIDDARMARG

Locality 3 *L.*—K14/948 and K 14/951. Liddarmarg at 10,600 ft. (lat. 33° 48′; long. 74° 39′). C. S. Middlemiss and H. de Terra have made collections from the beds exposed in the neighbourhood of the village.

Both the above collections seem to have come from one and the same horizon but they have probably been made from different spots near each other. The clay here is grey-black and well bedded, of the same nature and texture as found in Laredura, Dangarpur, Nagbal, Botapathri and Gogajipathri, but the flora discovered from these localities (excepting Botapathri) is very different in species from Liddarmarg flora. The latter beds have yielded a large number of leaves of *Machilus* sp., about 70% of leaves of two species of oaks, namely, *Quercus glauca* Thunb., *Quercus incana* Roxb., about a dozen leaves of *Acer oblongum* Wall. A solitary leaf of *Pittosporum eriocarpum* Royle, a couple of leaf fragments referred to *Ficus Cunia* Buch-Ham. and a few other leaves, which are not found in any other locality excepting Botapathri, from where a few leaves of the same species of *Quercus* are recorded. The collection of Middlemiss is richer in species than that of de Terra.

(21) *Middlemiss's locality.*—K14/951 and K14/948. The following description of the Liddarmarg plant beds is taken from a paper of Middlemiss (1911, pp. 121-122) published in the Records of the Geological Survey of India.

"They are exposed in two little stream beds near the present Gujar (herdsmen) encampment of Luddarmarg [this is given as Liddarmarg in the text], (lat. 33° 48′; long. 74° 39′). The dip is of the usual slightly inclined character, and the beds were found to contain a flora of well-preserved leaves. In the damp state in which they were extracted, the leaves had much the same toughness as a photographic film, but on exposure to the air in a dry climate, they crumbled away. Fortunately by wrapping up the specimens as they were gathered in many folds of paper and packing them up on the spot, they were eventually able successfully to withstand the journey to Calcutta."

(22) *H. de Terra's locality.*—Loc. 3 L. The following description of this locality is taken from a letter (kindly given to me by Prof. Sahni) dated New Haven, Connecticut the 16th Sept. 1933 from Dr. H. de Terra to Dr. S. K. Mukerji :—

"Locality 3. Topographic sheet 43K9: A 3. Stream bed 500 ft. west of shepherd's huts of Luddarmarg at 10,500 ft. above sea-level. Sandy shales alternating with grey *flat clay dips 6 degrees north-east.*"

CONDITION OF THE MATERIAL

Most of the material described in this paper consists of leaf-impressions preserved in a fine grained grey or at times yellowish clay. In addition to leaf-impressions, there are quite a few specimens of mummified leaves and fruits; also some seeds, cones, bits of wood and bark occurring in a perfect state of preservation form a part of the material. Among the leaves the mummified specimens are relatively much fewer but fruits of the two speceis of *Trapa* provide perfect samples of plant mummies. Most of the fossil fruits and seeds (excepting fruits of *Trapa*, oak, *Cornus*, *Ranunculus* and Ivy) are of the winged type, *e.g.*, samaras of *Acer* and *Fraxinus*, achenial fruits of *Clematis* and winged seeds of Coniferales. There are also some achenial fruits of *Clematis* with their persistent hairy styles.

Excepting Prof. Sahni's collections and my own specimens, the rest of the material had been coated with one or other kind of paint in the field or in laboratory before it came into my hands. Various dilutions of varnish, Canada balsam, gelatine, "duco" and rubber solution had been employed by different people. Middlemiss did not coat the specimens in the field but they were painted in the laboratory at Calcutta. He writes that "there by painting them, at Mr. Blyth's suggestion, with gelatine first and Canada balsam varnish afterwards, I was able to preserve a large number showing all the delicate venation, serrated edges, and in one or two instances even the deep red tints of the original fallen leaves" (Middlemiss, 1911, p. 122). De Terra and Stewart followed another

method; they applied a thin layer of rubber solution to a few, coated some with duco and painted the rest with varnish diluted with turpentine oil in the field. Quite frequently the specimens were first coated with duco and then with varnish or gelatine to clear the venation obscured by the former. This was done partly with an intention to save the specimens from spoilage on the way, and partly with a view to save the organic matter of the leaves still preserved in the specimens from being peeled off the clay. This treatment proved fairly satisfactory for the former purpose, and except for a little unavoidable breakage in transport the specimens were brought to the laboratory in a perfect condition. The second aim too was largely fulfilled as the organic matter remained sticking to the clay and withstood the jolting etc. during transit. But these treatments spoiled the specimens in other respects. The rubber solution and "duco" obscured the venation and many good specimens were rendered indeterminable and useless. The varnish proved useful in this respect that it cleared the venation, but it gave a false colour to the specimens in some cases and the former gave bad results in photography. Experience has shown that some untreated specimens show up better in photographs than those which have been varnished. But some kind of painting is absolutely necessary in some specimens to show the venation, which is otherwise badly preserved or obscured; cedar wood oil serves the purpose quite well. In specimens in which the organic matter is too much shredded and broken for any cuticular study, a thin coat of cedar wood oil or a colourless varnish would prove very advantageous in study as well as in photography and should better be applied in the field just after the specimens are collected. Leaving aside "duco" and rubber solution, which were hopeless in every respect, the varnish spoiled those specimens, in which the organic matter was preserved, as it involved great difficulties in cuticular preparations. Very tiny fragments of the badly cracked matter, stuck together by duco, rubber solution or varnish when transferred to maceration fluid, broke into bits, too small for further study. In spite of the most careful efforts it was not possible to remove these paints from the cuticle, before or after the maceration, without greatly damaging the latter. The slightest trace of "duco" or rubber solution left with the cuticle after maceration not only obscured the structure of the latter but assumed false cellular pattern by folding so as to be easily confused with the true cellular structure. Worst of all, these layers acquired a false colour while passing through ammonia and the former gave it an organic look. In a desperate attempt to get rid of them by mechanical methods under a binocular microscope I broke the cuticle, which was already in very small bits, into still further and smaller pieces. Dr. K. Jacob of the Geological Survey of India suggested amyl-acetate to remove duco from the leaf material. This did not succeed on account of two reasons. Firstly, because of the heavy thick coating the specimen had to be immersed in the amyl-acetate solution for several days before any dissolution would start. The second difficulty in the way was due to the uneven coating. A specimen was dipped in amyl-acetate for three days without any visible change; the dissolution appeared to start after the fourth day. This happy sign made me optimistic, but all hopes were shattered on the next day, when it was found, to my great disappointment, that a few tiny bits of the badly cracked cuticle were floating in the amyl-acetate solution. These floating bits had been peeled off the clay along with the "duco" layer. This revealed that the real defect lay in the organic matter itself which was too badly cracked and came off the clay only in tiny bits which are too small for maceration purposes. My efforts with the varnished leaves also met with no better success. Unfortunately some of the good specimens were coated with two or more paints and to remove them, the help of chemist friends was sought, but their efforts, too, did not improve matters.

Big blocks of clay, when unearthed, had to be dried in sun as they were very wet. The fossils, when freshly cut, turned black or brown on contact with air. The specimens were wrapped carefully in many folds of paper with plenty of cotton padding.

Fossils from Laredura, Dangarpur, Gogajipathri and Liddarmarg are very well preserved. Organic matter is preserved in a few of them while the others are only impressions. They occur in a fine-grained tough clay,

which splits out irregularly and with difficulty. The leaves lie embedded in a horizontal plane. Some of the larger leaves are fragmentary due to cracks in the clay but the smaller leaves split out perfect. The Laredura specimens are 50% complete leaves. Their well preserved nature regarding the small details of nervature permits one to say that they were probably deposited in quieter waters and had not travelled for a long distance before reaching the site of deposition. The latter probability is also suggested by the undamaged state of the leaves, the winged fruits and seeds.

The Ningal Nullah specimens do not have any trace of organic matter on them but they are very good impressions. The clay at these places is very well bedded into thin layers. The specimens from these places split out fragmentarily due to the soft nature of the clay. This material was very greatly damaged in transport from the field to the laboratory. A thin layer of varnish applied on the specimens did a lot of good in clearing the venation.

PREVIOUS WORK

Since 1864 when the discovery of plant and animal fossils was made in the Karewa beds by Godwin Austen a long span of time passed before any systematic attempt was made to work out the palaeontology of the Karewa clays. Among the few specimens collected by Godwin Austen, some land and fresh water shells, a few bits of fish scales, and a number of imperfectly preserved plant fossils were recognised (Godwin Austen, 1864, p. 383 and Middlemiss, 1911, p.121). A mention may here be made of another small collection of plant-fossils made by E. J. Jones of the Geological Survey of India in 1885 from Laredura. This material is said to contain only a few badly preserved fruits of one species of *Trapa*. But what else it does contain is unknown because on my request to the Director of the Survey, for a loan of Jones's collections I was given the reply, "I understand from Dr. Jacob of this Department that you have already studied several well preserved specimens of the same species of *Trapa* in Prof. Sahni's collection. So I presume it will not serve any useful purpose to send you this collection". (1). From what is revealed below by my revision of Burkill's identifications of Middlemiss's collection from Liddarmarg it seems that a critical examination of the Jones's collection at the Geological Survey, which has never been reviewed since 1885, would not do any harm.

So the first important collection, which contained recognisable plant-remains, was that of Middlemiss who gathered in 1910 about 80 pieces of rocks containing more than 200 fossil leaves and a few fruits from Liddarmarg. Middlemiss (1911, p. 122) made a preliminary study of the collections and with the help of Mr. I. H. Burkill, who was then Reporter on economic products to the Government of India five genera were believed to have been identified. The most common specimens were leaves of an oak, which were specifically determined as *Quercus glauca* Thunb.; a few leaves of *Cinnamomum*, one of which was considered to be *Cinnamomum Tamala* Nees., two leaves of *Alnus*, one specimen of *Buxus sempervirens* Linn. and a single leaf resembling *Jasminum* were also recognised.

This collection was later loaned to me for study in 1939 and I identified as many as 20 different genera and 25 species of modern plants in this material. As the original labels bearing the identifications, were made available to me with the specimens, it has made it possible for me to compare below Burkill's identifications as given by Middlemiss with my own in a tabular form :—

(1) Letter No. 6838/211 (4) dated Calcutta the 21st June 1940 from the Director, Geological Survey of India, Calcutta, to the author.

Middlemiss's label with the specimens.	My determination.	Remarks.
Quercus ..	A few *Quercus glauca* Thunb. and others *Quercus incana* Roxb.	29 specimens bearing the number K14/948 a 1—a 29.
	Besides the leaves of *Quercus* sp. I have determined a few more species from these specimens and they are given below with the Registered Nos. of the specimens.	
Quercus sp. ..	*Machilus* sp.	K14/948 a. 7
,, ..	*Toddalia aculeata* (?)	,,
..	*Murraya* sp. (?)	
,, ..	Cupule of *Quercus* sp.	,, a. 8
,, ..	*Acer oblongum* Wall.	,, a. 9
,, ..	*Acer oblongum* Wall.	K14/948 a. 13
,, ..	*Acer oblongum* Wall	,, a. 14
,, ..	*Desmodium* sp.	,, a. 15
,, ..	*Cornus capitata* Wall., fruit.	,, a. 16
,, ..	*Desmodium* sp.	,, a. 17
,, ..	*Typha* sp.	,, a. 17
,, ..	*Brachyphyllum* sp.	,, a. 17, a. 17,
,, ..	*Pittosporum eriocarpum* Royle	K14/948 a. 19.
,, ..	*Acer oblongum* Wall	,, a. 22
,, ..	*Acer oblongum* Wall.	,, a. 23.
,, ..	*Litsea lanuginosa* Nees.	,, a. 27
,, ..	*Phoebe lanceolata* Nees.	,, a. 28.
,, ..	*Quercus glauca* Thunb. and *Quercus incana* Roxb.	K14/948 B
,, ..	*Quercus incana* Roxb.	,, c. 1
,, ..	,, ,,	,, c. 2
,, ..	,, ,,	,, c. 3
,, ..	*Phoebe lanceolata* Nees.	,, c. 4
,, ..	*Ficus nemoralis* Wall.	,, c. 4
Alnus ..	*Alnus nepalensis* D. Don. *Quercus* sp.	K14/948 (*i*)
,, ..	*Alnus nepalensis* D. Don.	,, (*ii*)
Buxus sempervirens Linn. ..	*Buxus Wallichiana* Baillon. *Quercus glauca* Thunb. *Quercus incana* Roxb.	K14/950
Cinnamomum Tamala Nees. ..	*Litsea lanuginosa* Nees.	K14/951 (*i*)
Cinnamomum Tamala Nees.	*Litsea lanuginosa* Nees *Buxus papillosa* C. K. Schn.	K14/951 (*ii*)
Cinnamomum Tamala Nees.	*Litsea lanuginosa* Nees.	K14/951 (*iii*)
,,	*Desmodium laxiflorum* D. C. *Berberis* sp.	K14/952
,,	*Ficus Cunia* Buch-Ham.	K14/953 (3)
,,	*Acer oblongum* Wall. *Quercus glauca* Thunb. or *Quercus incana* Roxb.	K14/953 (6)
,,	*Acer oblongum* Wall, and *Quercus glauca* Thunb.	K14/953 (7)
	Quercus glauca Thunb.	K14/953 (8).

It is apparent from my determinations given in the above table that *Cinnamomum Tamala* Nees., *Buxus sempervirens* Linn. and *Jasminum* do not form components of the Middlemiss's collection and that the *Alnus* and *Quercus* of Burkill are *Alnus nepalensis* D. Don, and *Quercus glauca* Thunb.

De Terra's collections of the first expedition were examined by the late Dr. S. K. Mukerji who identified several genera including *Quercus*, *Salix*, *Populus*, *Buxus*, *Alnus*, *Berberis*, *Rhododendron*, *Rosa*, *Ilex*, (?) *Parrotia*, *Vallisneria*, *Cinnamomum*, *Trapa* and Charophytes, which were announced by De Terra (see De Terra and Wodehouse, 1935, p. 1) and later by Sahni (1936, p. 12). My intensive studies of the macroscopic remains of these collections have revealed that the genera *Salix*, *Populus*, *Buxus*, *Ilex*, *Vallisneria* and *Cinnamomum* are not represented in this material, however, *Salix* and *Populus* are identified from collec-

tions made later from other places by De Terra in 1935, Stewart in 1936 and the author in 1939, 1940 and 1941. Fossil leaves of *Buxus* referable to two modern species *B. Wallichiana* and *B. papillosa* are identified from Middlemiss's collections from Liddarmarg. The genera *Ilex, Cinnamomum* and *Vallisneria*, which are not represented in any of the collections are therefore excluded from the Karewa floras as it will be seen that these genera do not occur in any collection examined by the author. I find from the notes left by Dr. Mukerji (kindly given to me by Prof. Sahni) that he could only make a very preliminary study of the material, so much so that he never got time to revise his notes even once before his death.

Wodehouse (see De Terra and Wodehouse, 1935, p. 5) described the following few genera from pollen-grains from the Karewa clays sent to him by de Terra.

Coniferae	..	*Pinus, Cedrus, Picea, Abies.*
Cupressineae	..	Genus not determined.
Gnetaceae	..	*Ephedra.*
Gramineae	..	Genus not determined.
Salicaceae	..	*Salix.*
Betulaceae	..	*Betula, Carpinus, Corylus, Alnus.*
Juglandaceae	..	*Juglans.*
Ulmaceae	..	*Ulmus.*

The author has examined winged pollen grains of Conifer genera (*Pinus, Abies, Cedrus, Picea*) together with many different kind of unwinged pollens, some of which belong to oak, birch, alder, willow, grasses, elm, *Nelumbo*, etc.

The author's preliminary studies of the macroscopic remains of de Terra's, Stewart's and Prof. Sahni's collections in 1938 revealed a rich fossil flora of 90 species distributed in 50 genera (Puri, 1939, pp. 127-128).

A preliminary list of the plants identified by me early in 1938 and photographs of about a dozen species (Puri, 1941, p. 8) which I had prepared at Lucknow have appeared (but under Dr. Stewart's name) in de Terra and Paterson's Memoir "Studies on the Ice Age in India and Associated Human Cultures" (1939, pp. 118-119 and plates LIII and LIV). Dr. Stewart's had sent to de Terra my list of species and a few of my photographs to show that work on de Terra's material was in progress. Below is given the complete list of plants :—

Woody Plants.

Ranunculaceae :
- *Clematis montana* Buch-Ham., winged fruit.

Berberidaceae :
- *Berberis ceratophylla* G. Don., leaves.

Aceraceae :
- *Acer Caesium* Wall. ex Brandis, samara and leaf fragment.
- *Acer pentapomicum* Stewart ?, leaf fragment.

Hippocastanaceae :
- *Aesculus indica* Colebr., parts of leaves.

Sabiaceae :
- *Meliosma pungens* Walp. ? ?

Papilionaceae :
- *Indigofera hebepetala* Benth. ? leaflets.

Rhamnaceae :
- *Rhamnus pupurea* Edgew. ? , leaf fragments.

Rosaceae :
- *Prunus jacquemontii* Hook. vel. aff., leaves.
- *Prunus cornuta* Wall., leaf fragments.
- *Prunus cerasifera* Ehr. vel aff., leaves.
- *Spireae canescens* D. Don ?, leaves.
- *Rosa webbiana* Wall. leaves, very small, appr. *R. beggeriana* Schrank.
- *Rosa macrophylla* Lindl., leaflets.
- *Pyrus communis* L. vel aff., leaf.
- *Pyrus foliolosa* Wall. vel aff., leaflets.
- *Pyrus aucuparia* Gäertn. vel aff., leaflets.
- *Pyrus pashia* Buch-Ham. ? leaves.
- *Cotoneaster microphylla* Wall., leaves.
- *Cotoneaster nummularia* Fisch. et Meyer, leaves.
- *Cotoneaster bacillaris* Wall., leaves.

Araliaceae :
- *Hedera Helix* L., fruit.

Cornaceae :
- *Cornus macrophylla* Wall. ? leaf fragments.

Caprifoliaceae :
- *Viburnum stellulatum* Wall. vel aff., leaf.

Oleaceae :
- *Fraxinus excelsior* L., winged fruits.

Cupuliferae :
- *Alnus nitida* Endl., leaves and fruit.
- *Alnus* sp., fruits, smaller.
- *Carpinus* ? leaves.
- *Betula utilis* D. Don., fruit and leaves.
- *Betula* sp., leaves.
- *Quercus incana* Roxb., many specimens (leaves).
- *Quercus semecarpifolia* Smith, many leaves.
- *Quercus Ilex* L., many leaves.

Quercus dilatata Lindl., many leaves.

Quercus glauca Thunb., leaves.

Castanopsis ? leaf fragments.

Juglandaceae :

Juglans regia L., two leaflets.

Ulmaceae :

Ulmus Wallichiana Planch., leaves.

Ulmus parvifolia Jacq., leaves.

Salicaceae :

Salix Wallichiana Anders., leaves.

Salix denticulata Anders., leaves.

Salix, two or three unidentified sp.

Populus alba L. ? , leaf fragment.

Populus nigra L., vel aff., leaves.

Populus ciliata Wall. ? , leaf fragments.

Coniferae :

Pinus excelsa Wall., fragments of needles.

Abies Webbiana Lindl., winged seeds.

Picea Smithiana Boiss., winged seeds.

Juniperus, leaf and crushed fruit ?

Taxus ? leaf.

Herbaceous plants.

Nymphaeaceae :

Nelumbium speciosum Willd., leaf fragment.

Hydrocaryaceae :

Trapa natans L., fruits.

Typhaceae :

Typha ?, pieces of leaves.

Ferns.

Adiantum pinnule ; differs from anything found now in Kashmir.

Dryopteris, near *filix-mas* (L) Schot, pinnules.

Selaginella ?

The preliminary results of my studies on the earlier collections of de Terra, and on a part of Dr. Stewart's material, were published in *Proc. Ind. Sci. Congress*, Lahore, 1939, p. 127 and *Ibid.*, Madras, 1940, pp. 146-147.

Later in 1940, when a detailed investigation of the entire material was carried on by the author at Lucknow, the results of this study were published annually in the form of very brief notes in "Palaeobotany in India" (Puri, 1940a, 1941, pp. 7-8 ; 1942, pp. 222-224 and 1943, p. 182). In addition to these the author published (1943, pp. 125-131) a full paper recording the occurrence of *Woodfordia fruticosa* from the Karewas of Kashmir and offered some remarks on changes of altitude and climate during the Pleistocene.

Two more papers were communicated to the joint meeting of the Indian Academy of Sciences and National Academy of Sciences held at Hyderabad in December 1943. The first paper (1943, p. 23) dealt with the description of some leaves of *Litsea lanuginosa*, which had been previously (incorrectly) identified by Burkill (See Middlemiss, 1911, p. 121 as *Cinnamomum Tamala*. The second (1943, p. 24) included descriptions of a few fossil leaves belonging to 9 species of the Salicaceae from Ningal Nullah and Laredura. Two more papers, one recording the occurrence of *Nelumbo nucifera* at Ningal Nullah and another describing some fossil leaves and female cones of the Betulaceae from the Karewas are recorded very briefly in "Palaeobotany in India" V.*

The Karewa flora is now known to comprise at least 122 species belonging to 62 genera and 34 families of angiosperms and 6 species belonging to 5 genera of gymnosperms, besides some ferns (Puri, 1942, p. 223).

Out of the 36 genera and 57 species listed in de Terra's memoir I would exclude 10 genera and 13 species which I believe to be not represented at all in the Karewa floras, for in spite of detailed studies of this material and later collections I have failed to recognise them. The species thus excluded are the following :—

1. *Clematis montana* Buch-Ham.
2. *Meliosma pungens* Walp.
3. *Prunus Jacquemontii* Hook.
4. *Prunus cornuta* Wall.
5. *Prunus cerasifera* Ehr.
6. *Spiraea canescens* D. Don.
7. *Pyrus foliolosa* Wall.
8. *Pyrus aucuparia* Gaertn.
9. *Castanopsis.*
10. *Populus alba* L.
11. *Adiantum* pinnule.
12. *Dryopteris* near *filix-mas* (L.) Schott.
13. *Selaginella.*

***Several papers listed in the Bibliography have since been published by the author.**

In addition to studies on the macrofloras of the Karewa beds, the microfloras have also been studied by another American worker Mr. Paul S. Conger, of the Carnegie Institution of Washington (see De Terra and Paterson, 1939, pp. 120-122). Conger has identified a large number of diatoms from the Karewa clays sent to him by De Terra. A list of the species is given below :—

Sample K 30. Kashmir (Karewa), India. Fresh-water clay belonging to Lower Karewa beds (first interglacial). Much lime. Diatoms present, but all badly broken.

Amphora ovalis var. *lybica* (Ehr.) Cl	S
Cymatopleura elliptica W. Sm ..	S
Cymbella ehrenbergii Ktz ..	C
Cymbella lanceolata (Ehr.) V. H. ..	C
Epithemia argus Ktz ..	C
Epithemia zebra (Ehr.) Ktz ..	C
Navicula ambigua Ehr. (*cratiular form*)	S
Navicula amphirhynchus Ehr.	S
Navicula cuspidata Ktz ..	S
Navicula viridis (Nitzsch) Ktz ..	F
Rhopalodia gibba (Ehr.) O. Müll ..	F
Stauroneis phoenicenteron Ehr ..	VC
Synedra ulna (Nitzsch) Ehr ..	S

(*Cymbella ehrenbergii* and the *Epithemias* dominate this sample).

Sample. Handawor (Lower Karewa beds). India. Fresh-water. Very soft dark-grey shale, peaty, containing numerous very minute snail shells. Much lime. Many and a great variety of diatoms.

Amphipleura pellucida Ktz ..	*VS
Amphora ovalis Ktz ..	F
Amphora ovalis Ktz. var. *lybica* (Ehr.) Cl ..	F
Amphora ovalis Ktz. *pediculus* Ktz	S
Cocconeis placentula Ehr. (and varieties) ..	VC
Cyclotella comta (Ehr.) Ktz ..	VC
Cymatopleura elliptica W. Sm ..	VC
Cymatopleura solea (Breb.) W. Sm ..	VC
Cymbella cesatii (Rabh.) Grun ..	*S
Cymbella cistula (Hemp.) Kirchn ..	C
Cymbella ehrenbergii Ktz ..	VC
Cymbella lanceolata (Ehr.) V. H. ..	F
Cymbella prostrata (Berk.) Cl ..	*S
Cymbella turgida (Greg.) Cl ..	*S
Cymbella ventricosa Ktz ..	F
Epithemia argus Ktz ..	VC
Epithemia sorex Ktz ..	C
Epithemia turgida (Ehr.) Ktz ..	C
Epithemia zebra (Ehr.) Ktz ..	C
Epithemia zebra (Ehr.) Ktz. var *porcellus* (Ktz.) Grun ..	C
Fragilaria capucina Desm ..	F
Fragilaria construens (Ehr.) Grun ..	S
Gomphonema capitatum Ehr ..	*S
Gomphonema constrictum Ehr ..	F
Gomphonema geminatum Ag. var. *hybrida* Grun ..	*S
Gomphonema intricatum Ktz. ..	C
Gomphonema lanceolatum Ehr. ..	C
Navicula amphisbaena Bory ..	F
Navicula bacilliformis Grun ..	VS
Navicula borealis Ehr ..	VS
Navicula (Pinnularia) brebissonii Ktz.	F
Navicula cuspidata Ktz. ..	F
Navicula (Neidium) iridis Ehr ..	*S
Navicula (Neidium) kozlowi Meresch	*S
Navicula limosa Ktz ..	*S
Navicula major Grun. Var ..	F
Navicula oblonga Ktz. ..	VC
Navicula polygramma Ehr. ..	VC
Navicula radiosa Ktz. ..	VC
Navicula viridis (Nitzsch) Ktz. ..	F
Nitzschia angustata (W. Sm.) Grun ..	F
Nitzschia hungarica Grun ..	C
Nitzschia palea (Ktz.) W. Sm. ..	S
Nitzschia sigmoidea (Ehr.) W. Sm ..	C
Pleurosigma attenuation Ktz. ..	VS
Pleurosigma kützingii Grun ..	VS
Rhoicosphenia curvata (Ktz.) Grun ..	VC
Rhopalodia gibba (Ehr.) O. Mull ..	C
Rhopalodia gibba (Ehr.) O. mull. var. *ventricosa* (Ehr.) Grun. ..	VS
Stauroneis anceps Ehr. ..	S
Stauroneis phoenicenteron Ehr. ..	S
Stephanodiscus astraea (Ehr.) Grun ..	VS
Surirella bifrons Ktz. ..	*VC
Synedra capitata Ehr ..	S
Synedra gaillonii (Bory) Ehr ..	S
Synedra obtusa W. Sm ..	S
Synedra pulchella Ktz. ..	VC
Synedra ulna (Nitzsch) Ehr. ..	S
Synedra ulna (Nitzsch) Ehr. var. *danica* (Ktz.) Grun ..	S
Sundedra vitrea Ktz. ..	*S

Sample K17 Kashmir (Karewa), India. Medium hard, dark-grey shale. Many minute snail shells. Much lime. Diatoms abundant, many broken.

Cocconeis placentula Ehr. ..	S
Cymatopleura solea (Breb.) W. Sm. ..	S
Cymbella ehrenbergii Ktz. ..	F
Cymbella lanceolata (Ehr.) V. H. ..	S
Cymbella ventricosa Ktz. ..	S
Epithemia argus Ktz. ..	F

Epithemia zebra (Ehr.) Ktz.	..	F
Gomphonema intricatum Ktz.	..	S
Navicula viridis (Nitzsch) Ktz.	..	S
Stauroneis phoenicenteron Ehr.	..	S

In addition to these Prof. M. O. P. Iyengar and Mr. Subrahmanyan (1943, pp. 225-237) have described 17 forms of diatoms representing ten genera, thirteen species, two varieties, one new variety and one new form from a piece of shale collected from Gulmarg (alt. 9,000 ft.) by Mr. Gautam Kohli, who presented it to Prof. B. Sahni. List of the species is given below :—

Pure Fresh-water forms.

Melosira distans (Ehrenb.) Kütz.
Fragilaria construens (Ehrenb.) Grun.
Eunotia robusta Ralfs.
Eunotia valida Hust.
Caloneis Schumanniana (Grun.) Cl., var. *biconstricta* Grun. *f. brevistriata* f. nov.
Stauroneis phoenicenteron Ehrenb.
Pinnularia gibba Ehrenb.
Pinnularia viridis (Nitzsch.) Ehrenb.
Cymbella parva (W. Sm.) Cl.
Cymbella aspera (Ehrenb.) Cl.

Fresh—and brackish-water forms.

Cocconeis placentula Ehrenb. var. *euglypta* (Ehrenb.) Cl.
Epithemia zebra (Ehrenb.) Kütz.
Epthemia Sorex Kütz. var. *gracilis* Hust.

Fresh-water, brackish-water and marine forms.

Cyclotella Meneghiniana Kutz.

(To be continued.)

SILVICULTURE OF TEN SPECIES OF BAMBOO SUITABLE FOR PAPER MANUFACTURE

By Jagdamba Prasad, Silviculturist, F. R. I., Dehra Dun

S/01, 02, 101, 102, 21, 23, 3, and 633/In., G-1146 and 92/In.-General description, distribution, habitat, growth, development, artificial cultivation, methods of felling, extraction, particulars of flowering, seeding and their effect on supplies of ten Indian bamboos, suitable for paper manufacture are given in the fullest possible details.

These notes on ten species of bamboo are put forth to assist in undertaking the planting and management of bamboos for the paper industry.

I.—Dendrocalamus Strictus, Nees

(*i*) *General Description.*

Dendrocalamus strictus is the best known, commonest, gregarious, most widely distributed and the hardiest of all Indian bamboos, deciduous, middle-sized, densely tufted, and with strong thick-walled or solid culms varying in size according to locality.

(*ii*) *Distribution and habitat.*

It is found in deciduous forests and dry and moderately dry regions all over India and Burma, except in northern and eastern Bengal and Assam. It is found typically on hilly country ascending to 3,500 feet. It is absent from Ceylon. Southwards it is said to extend to Singapore and Java. In the valleys of Burma and South India, it reaches a large size with hollow culms, longer leaves and culm sheaths; but in the dry Deccan hills and in the Siwaliks, it is smalll and has nearly solid culms, small leaves and sheaths.

(*iii*) *Growth and development of culms and clumps and artificial regeneration of the species.*

The culms are variable in size according to climate, 20 to 50 feet high, 1 to 3 inches in diameter, glaucous-green when young, nodes somewhat swollen and in open situations bearing leafy, often deflexed branches, even from the base, lower nodes often rooting; internodes short 12 to 18 inches long; upper branches curved, drooping; walls thick. Culm sheaths variable, lower ones shorter, 3 to 12 inches long, covered on the back with golden brown stiff hairs, sometimes glabrous in dry localities.

The seed of *Dendrocalamus strictus* is similar in form to and about half the size of unhusked wheat. Seeds weigh 800 to 1,560 to the ounce, with a germinative capacity of 25 to 80%.

For direct sowing the soil should be dug up to a depth of about 4 to 6 inches (deeper on poor soils), in patches (spacing 10 to 15 feet square). One pound of seed will suffice for one acre.

For transplanting, pits 9 to 12 inches deep with a diameter of 6 to 9 inches (spaced 10 to 15 feet square) may be prepared beforehand. Seeds should be sown in nursery beds in drills 9 inches apart and lightly covered. A nursery bed 35′ × 5′ will need about half to one pound of seeds and yield about 4000 plants. Transplanting can be done when the seedlings are 6 inches to 18 inches high, in about 1 or 2 months, plants being dug up from the nursery with as much earth as will adhere to them.

Rhizome planting is, however, superior to transplanting or direct sowing. Planting separated rhizomes is a better method than planting multiple ones, as the latter give two or more separated rhizomes, and survival percentages are generally in favour of the separated rhizomes.

(*iv*) *Methods of felling and extraction.*

Fellings are done on cycles of 2 to 4 years. New culms are not felled and a certain number of older culms are also retained. The height of cutting is also regulated. The best felling cycle is perhaps one of three years, if all culms of the year are retained, together with about 8 mature culms per clump. Where intensive working can be closely supervised as in East Punjab a cycle of two years is justifiable.

Shoots from clear-felled and burnt clumps are known to have produced solid culms in the first as well as in the second year. The latter were stronger and more suitable to meet the Ordnance requirements.

(*v*). *Particulars about flowering and the effect of flowering on supplies.*

Dendrocalamus strictus flowers irregularly, that is, a few culms in a clump here and there or a few clumps in one locality come into flowering, while at times it flowers gregariously over large areas. The flowering cycle is more or less constant in one locality, but differs from that of the others. Thus for Burma it may be taken as 25 years, for the Central Provinces as 21 years, for Madras as 28 years and for the United Provinces as 38 years, on the average.

Flowered bamboos are quite suitable for making paper pulp even when they are cut a year or two after seed fall. Experiments at the forest research institute, Dehra Dun, showed that bamboo which had flowered 4 years previously, was quite good for paper pulp, and even gave a better yield of paper per ton. The quality of paper was as good, as that from living clums, although comparatively longer digestion was necessary, though the total quantity of culms used for digestion was the same.

II.—Dendrocalamus Hamiltonii Nees and Arn

(*i*) *General description.*

A large tufted bamboo, with cæspitose stems, sometimes growing tall and erect, but more often sending out its stems at an angle or curved downwards. It forms, impenetrable thickets; the inner stems of a clump are often upright and clear of branches, somewhat resembling *Dendrocalamus giganteus.* The species is very easily identified by its panicles of bright purple-red flowers; and when out of flower the grey stems, long nearly glabrous stem sheaths and straggling habit cause it to be easily recognised. The long hairy points to the anthers are also remarkable.

(*ii*) *Distribution and habitat.*

It is found in the central and eastern Himalaya from Simla eastward up to 3000 feet, in Assam, Garo, Naga and Khasia hills and Sylhet and Katha, Bhamo and Ruby mines in Upper Burma, Lower Burma and Garhwal to 4,000 feet. In Burma it occurs in moist places along streams and in valleys often bending over and forming dense thickets.

(*iii*) *Growth and development of culms and clumps and artificial cultivation of the species.*

Culms attain sometimes a length of 80 feet, are white-pubescent when young, soft and thin-walled, mostly overhanging and often horizontal, branching, the branches often single and as long as the main stem. Internodes 12 to 20 inches long, 4 to 5 inches in diameter, walls $\frac{1}{3}$ to $\frac{1}{2}$ inch in thickness. Culm sheaths stiff, persistent, often as long as internode, convexly truncate at top, blade ovate-lanceolate, up to 12 inches long. The branches on the lower portion of the stem are usually seated on woody knobs as large as a fist, and at these nodes, when the branches have not or have only imperfectly developed, are large very conspicuous swellings (arrested or half developed buds), covered with brown shining undeveloped sheaths. These buds are above the lower oblique node ring (scar of the fallen culm sheath) and below the upper

ring, on which often abortive rootlets appear; their shape is lenticular and they often extend over half the circumference of the culm. The Burmese name (Wabomyetsangye) indicates the resemblance of this swelling to the eye.

The species is frequently cultivated in the western sub-Himalayan region, for example at Dehra Dun and in other valleys. Cultivation is similar to that of *D. strictus*.

(iv) Methods of felling and extraction.

Fellings are done on a cycle of four years. The rules for cutting are :—

(1) Only culms three years old and over are to be cut from a clump and twice as many old culms as there are new shoots in the clump should be left. The clums selected for retention should be in full vigour of growth and not overmature. A third year's culm is recognisable by absence of sheath and the white mealy powder on the stem.

(2) Cutting should be done, as far as possible not more than two nodes above the rhizome, and just above a node, *i.e.*, not more than a foot from the rhizome.

(3) The outer culms being almost always young, cutting should be done from inside the clump, as far practicable.

For extraction it is possible to float the bamboos down a river if one is available.

(v) Particulars about flowering and seeding and the effect of flowering on supplies.

The bamboo flowers sporadically and also gregariously. Supplies are bound to be affected in the case of gregarious flowering and therefore the best method is to tackle the flowered areas, stopping work in the unflowered ones till the fomer is fully exploited.

III.—Dendrocalamus Longispathus, Kurz.

(i) General description of the species.

A large tufted bamboo with leaves borne only on the upper branches. A handsome species at once recognised by its long fragile papery sheaths and by the large panicles of small flower heads and blunt spikelets. It comes nearest to *D. hamiltonii* in its general characters, but is easily recognised from it.

(ii) Distribution and habitat.

Eastern Bengal (Sylhet, Chittagong) and Burma (Arakan) along streams and in the moister parts of the upper mixed forest, on moist fertile loam. Also found in Pegu, Martban and Tenasserim.

(iii) Growth and development of culms and clumps and artificial cultivation of the species.

Culms 60 feet, glaucous or nearly white when young, lower half naked, often with a ring of rootlets at the nodes, internodes 18 to 30 inches long, 3 to 5 inches in diameter, walls $\frac{1}{3}$ inch thick, node line horizontal, undulate, hardly thickened. Culm-sheaths densely clothed on the outside with dark (almost black) stinging hairs, thin fragile, but long persistent, 14 to 36 inches long, overlapping the internodes, blade recurved, narrow, early deciduous, a little shorter than sheath, ligule a broad band of closely packed long hairs.

Seeds weigh 3200 to 5400 (F. R. I.) and 2367 (Madras) to the ounce and may be collected in March or April. In air-tight tins seeds keep good up to 3 months and then rapidly deteriorate.

Seeds may be sown in boxes and beds, under cover. They germinate in 8 to 15 days. When 6 inches high the seedlings may be pricked out into beds and as soon as they are 4 to 5 feet high may be transplanted into $1\frac{1}{2}$ feet cube pits spaced 20 feet apart. Madras reports 50% survivals in the sixth year of planting one year old rhizomes with a mean height of about 60 feet. Damage from porcupines is a liability.

This species can also be propagated by burying fresh culms horizontally, when shoots are sent up from each node. This bamboo can be planted in ravines up to 4,000 feet. It can also grow in poor stony soil.

(iv) Methods of felling and extraction.

The usual selection method will be applicable on a cycle of 3 years.

(v) Particulars about flowering and seeding and the effect of flowering on supplies.

Dendrocalamus longispathus is often found flowering sporadically. Gregarious flowering has also been reported both from Chittagong hill tracts and Burma.

The clumps die after flowering and it will be sometime (about 6 to 10 years) before the young crop can produce exploitable culms.

The best solution lies in stopping exploitation in unflowered areas till the flowered areas are fully exploited.

BAMBUSA ARUNDINACEA, WILLD.

(i) General description of the species.

A large, graceful, very densely tufted, thorny bamboo, with bright green, fairly thick-walled culms, which produce quantities of thorny branchlets, interlacing into a dense mass and rendering the culms difficult to extract from the clump.

(ii) Distribution and habitat.

Bambusa arundinacea is found throughout the greater part of India, Burma and Ceylon, excepting the Himalayan and sub-Himalayan tract and the valleys of the Ganges and the Indus. It is scarce in the Central Provinces, but occurs in Guzerat. It is very common in Orissa, in both its small and large varieties, in the Circars and Karnatic. It is abundant in the forests of the west coast from north Kanara southwards, particularly on flat ground near rivers and streams. In Burma it is common in parts of Pegu and Martban, in the Moulmein neighbourhood and in the Salween and Thaungyin drainages, often along the banks of rivers. It is somewhat scarce in lower Assam, eastern Bengal and Chittagong.

It is probably found in its largest size and finest condition in the hills of the Circars, especially about the Godavari, on the hill ranges of the eastern and southern scarps of the Mysore plateau, and in the Nilgiris, ascending to 3,000 feet and occasionally higher. The finest clumps are those in the Rumpa country north of the river Godavari.

(iii) Growth and development of culms and clumps and artificial cultivation of the species.

The culms are variable in length, but in large specimens attain a height of 80 to 100 feet or more and a diameter of six or seven inches, forming dense clumps of large size. The culms are rather soft-wooded, though stout, and have cavities in diameter nearly one-third of that of the culm. The culms are branched from the base, the lower joints giving out horizontal shoots armed at the nodes with two to three recurved spines and with few leaves; internodes variable in length, 12 to 18 inches long, often faintly angular and in smaller culms flattened on one side; walls thick, one to two inches. Culm sheaths coriaceous, orange yellow when young often striped with green and even red, variable in shape and size, but running up to 12 to 15 inches in length, and 9 to 12 inches in breadth, striate, somewhat rounded at the top and plaited on the edges, thickly ciliate with golden hairs, when young, otherwise glabrous.

Bambusa arundinacea is very largely cultivated everywhere, as in Dehra Dun and in places at the foot of the Punjab Himalaya. It occurs in ravines near water in the sub-Himalayan tract of Kumaon, where it has been introduced. Seeds vary from 2,080 to 2,900 to the ounce, with a germinative capacity of 38% (Madras). February to April are the months for the collection of its seed. Direct sowing of seeds at site is not recommended. Seedlings can be raised in the nursery for transplanting. Tentative conclusions drawn from experiments done in Madras, however, indicate that for the artificial regeneration of this species, it is better to plant one or two years old rhizomes rather than sow or transplant from the nursery.

If direct sowing has to be done, it is best to soak the seed for 48 hours in cold water before sowing. This results in much quicker germination and hence less damage by rodents.

In the selection of the site for planting this bamboo, areas liable to inundation and those with sandy soil should be avoided.

This bamboo can also be regenerated by planting offsets. The offsets are made from the south-west monsoon culms of the previous year. They must have a bushy bunch of roots and a good rhizome. They are cut three feet long and are planted in pits 1½ feet deep, usually two nodes being buried. Mature culms are ready about the fifth year. The offsets will not stand a drought after planting unless watered; and unless they are made from young clumps they are liable to flower and die at an early age.

(iv) Methods of felling and extraction.

Clear-felling or half clear-felling clumps is detrimental to the health of the clumps, which either die or take many years to recover their vigour. Selection fellings by which older culms are thinned out is the only practical method of management. However, from results of clear-fellings, clumps were found to have grown up to normal size after seven years

and a felling cycle of ten years on the clear-felling system was proposed for adoption in Angul (Orissa).

The felling cycle adopted for selection fellings is 3 or 4 years. There may be slight variations, but the main felling rules usually stipulate :—

(1) that the shoots will not be cut higher than one foot from ground level;
(2) that no culms younger than 18 months old will be cut;
(3) that a minimum number (ten or eight) of old culms per clump will be left;
(4) that no exterior shoots will be cut; and
(5) that all dead bamboos will be cut.

Bamboos are cut and carted to rail-head or river. Green bamboos lose about 40 per cent of their weight until they reach a constant and so $1\frac{2}{3}$ tons of green freshly cut bamboos represent one ton of air-dry material.

(*v*) *Particulars about flowering and seeding and the effect of flowering on supplies.*

The species occasionally flowers sporadically, but is one characterised by marked gregariousness in flowering. According to BRANDIS the flowering cycle is 30-32 years.

The clumps die down after flowering, but reproduction from seeds is abundant. The period a seedling requires to form a clump of full-sized stems is between 8 and 12 years. When gregarious flowering takes place the usual procedure is to stop extraction from non-flowering areas till the whole of the flowered out bamboos are exploited.

V.—Bambusa Polymorpha, Munro

(*i*) *General description of the species.*

A large handsome, tufted bamboo, evergreen, sometimes leaf-shedding in dry seasons.

(*ii*) *Distribution and habitat.*

It is found in eastern Bengal and in Burma. It is a common species in the upper mixed forests of the Pegu Yoma, abundant above 500 feet and rare in Martban, often associated with teak, extending north-westwards into Sylhet.

It flourishes best and reaches its largest dimensions on the lower slopes and well-drained valleys of the Pegu Yoma, on deep moist fertile loam. It is not found in the driest part of the range. On deep, rich, well-drained soil it is gregarious to a marked degree.

(*iii*) *Growth and development of culms and clumps and artificial cultivation of the species.*

Bambusa polymorpha has dense clumps. Culms clean and 50 to 90 feet high, 3 to 6 inches in diameter, grey to greyish-green white-scurfy when young, nodes thickened, lower ones fibrous-rooted; internodes 15 inches to two feet long; naked below, much branched, above and curving outwards. Culm sheaths with large auricles are thick, 6 to 7 inches long and 12 to 14 inches broad, covered on the back with densely and closely appressed white pubescence, sub-attenuate upwards and curvedly truncate at about 5 to 6 inches in breadth.

The culms have moderately thick walls and large cavities.

The species does well on well-drained sites. Seeds are collected in March. They weigh 750 (F. R. I.) to 1396 (Madras) to the ounce, with a germinative capacity of 40%. Seedlings are raised in nurseries and planted out. Madras reports survival percent as 49 to 92, with an average height of 47′ and over 30′ at the end of the seventh growing season, where *Bambusa polymorpha* was raised by planting two-year old rhizomes.

Plantations are expected to repay the cost of formation in about eight years. According to BRANDIS *Bambusa polymorpha* that had flowered in the Pegu Yoma hills in 1859 had grown up into a forest similar to that before flowering in 1868; the tufts were, however, very small, that is they had not then as many stems as formerly.

(*iv*) *Methods of felling and extraction.*

Selection fellings on the lines of those indicated under *Bambusa arundinacea* on a cycle of three years may be done. In fact such fellings in the present state of our knowledge are the only safe methods of dealing with tufted bamboos.

(*v*) *Particulars about flowering and seeding and the effect of flowering on supplies.*

The species flowers at long intervals and the flowering is remarkably gregarious. The estimated life cycle is 60 years. Sporadic flowering has also been reported.

Supplies of a district at the most can be affected due to gregarious flowering, but rarely if ever will the treatment of stopping extraction from unflowered areas till the produce of the flowered out areas is dealt with cause serious dislocation.

VI.—Bambusa tulda, Roxb.

(*i*) *General description of the species.*

A caespitose, evergreen or deciduous, gregarious, arboreous bamboo, branching freely from nearly all the nodes, the branches from the lower nodes being thin, nearly leafless and more or less horizontal.

(*ii*) *Distribution and habitat.*

A native of Assam, Bengal, northern Circars, Chittagong and Burma. In Burma it is frequent on flat alluvial land along streams in the mixed deciduous forests and along the banks of the dry watercourses.

(*iii*) *Growth and development of culms and artificial cultivation of the species.*

The culms are green or glaucous when young, grey-green, when older, sometimes streaked with yellow, 20 to 30 feet high; internodes 1 to 2 feet long, 2 to 4 inches in diameter, walls 0.3 to 0.5 inches. Culm sheaths 6 to 9 inches long and 6 to 10 inches broad at the base, polished within, blade triangular, cuspidate, slightly hairy within, base decurrent into large rounded long-fringed auricles or into a wavy band along the upper edge of sheath.

There are 455 (Madras) to 1000 (Bengal) seeds to the ounce, with a germinative capacity of 39%. Seeds may be collected and sown in the nursery in May and seedlings transplanted when about 12 inches high in July. Rhizomes 18 inches to 24 inches long including the stem with one or more buds and roots can also be planted in prepared pits and it is easier to regenerate by planting rhizomes than by sowing seeds.

Bambusa tulda has aerial roots on the first nine or ten nodes and a practical method of propagating the species is by layering culms known to be about 3 years old, complete with branches. The lowest nodes strike roots almost immediately and about 66% of the nodes throw out roots within two months of setting. About 23 plants can on the average be obtained from a single stem.

(*iv*) *Methods of felling and extraction.*

Felling rules on a cycle of four years require that

(1) no culms less than a year old be cut;

(2) no shoot be cut at more than one foot above the root, except where the congestion of the clumps renders this impossible;

(3) a minimum of six mature culms be left in each clump;

(4) removal of culms with rhizomes be prohibited;

(5) fellings should begin on one side of the clump only, *viz.,* the side opposite to that where the largest number of young culms are found.

(*v*) *Particulars about flowering and seeding and the effect of flowering on supplies.*

Bambusa tulda often flowers sporadically or in small groups while gregarious flowering also takes place, of which the following cases have been recorded:

Assam.	1910,	Sylhet.
	1929-30,	Sylhet.
Bengal.	1867, 1872, 1884.	
	1876, 1886.	Chittagong.
	1919-20.	Chittagong hill tracts.
	1930.	Chittagong (seeds offered for sale at Rs. 2 per ounce).
	1931.	Chittagong.
	1936.	Chittagong.
Burma.	1865,	Tharrawaddy.
	1903-5.	Ditto, fairly extensive.
	1908.	Prome.
	1911.	Gangaw.
	1913.	Toungoo, Zigon, Rangoon.
	1913-14.	Universal throughout the Yomas.
Bengal.		Flowering cycle is estimated as 35 to 40 years.
United Provinces.	April 1939.	Ramgarh, Dehra Dun.
Burma.	1914.	Southern Toungoo, Pegu, Prome, Zigon, Tharrawaddy, Rangoon, Henzada, Yaw.
	1915.	Northern Toungoo, Prome, Shwegyin, Zigon.
	1915-17.	Southern Shan States.
	1938-39.	Palwe & Kaing ranges, Pyinmana.

It takes about 6 to 10 years for the new crop to mature.

VII.—*Melocanna bambusoides*, Trin.

(*i*) *General description of the species.*

An evergreen bamboo with single culms arising at a distance of 2 feet apart, more or less, from a ramifying underground rhizome. It is a typically gregarious bamboo, handsome and one of the most valuable and important of the Indian bamboos.

(*ii*) *Distribution and habitat.*

It is found in eastern Bengal and Burma, from the Garo, Khasia and Lushai hills to Chittagong and Arakan and again in Tennasserim. It forms extensive forests in Arakan and the Upper Chindwin. Its real home is in the Chittagong hill tracts, where it is gregarious, covering large areas of country.

(*iii*) *Growth and development of culms and clumps and artificial cultivation of species.*

Culms distant, green when young, straw-coloured when old, 40 to 70 feet long, the lower two-thirds bare of branches, sometimes with a few short branchlets at the lowest nodes, internodes, 10 to 22 inches long, 1 to 3 inches in diameter, smooth, walls thin. Culm-sheaths firmly coriaceous, persistent, brown, contrasting with the bright green of the young internodes, 5 to 7 inches long, upper third wavy, not appressed to the culm, sparsely hairy outside, top concavely truncate with rounded auricles, blade recurved, narrow ($\frac{1}{3}$ the top of sheath), longer than sheath, evenly narrowed into a long convolute apex, glabrous and striate on both sides.

The germinative capacity of the seeds is 11% (Bengal) to 56% (Madras). Seeds may be collected in July. 32 fruits weigh one pound. As both the roots and the shoots are produced at the thick end of the fruit, it seems unnatural to put the beaked end downwards for sowings. A possible alternative method may be to sow the fruit broadside on.

It is easier to regenerate the species by planting rhizomes than by sowing seeds. It can get on fairly in rocky exposed soil. Rhizomes with one or more buds may be planted at a spacing of 12′×12′.

(*iv*) *Methods of felling and extraction.*

Exploitation of all exploitable culms is not beneficial to the future crop and will not give a sustained yield. Annual fellings result in a gradual falling off both in quality and quantity. A three-year cycle appears best, for although the production of culms is not as good as on a two-year cycle the yield is slightly better.

Exploitable bamboos are more that one season old and have a minimum diameter limit of one inch at the middle of the internode nearest to $4\frac{1}{2}$ feet from the ground. A minimum length of 12 cubits (18 feet) without any defect in the culm is the standard size. Height of felling is approximately 2 to 3 feet above ground level.

(*v*) *Particulars about flowering and seeding and the effect of flowering on supplies.*

This bamboo flowers gregariously over large stretches of country. No new culms are produced the season before flowering takes place. The flower buds are first visible about September or October and flowering takes place in December or January. Soon after the flowering the leaves wither and fall, the culms turn yellow and the fruit forms rapidly, ripening and falling about April to June. The fruit is large, fleshy, and pear-shaped, 3 to 5 inches broad, the stalk being inserted at the thick end and the apex terminating in a curved beak. The thick fleshy pericarp if filled with starch and the fruits are readily devoured by cattle, elephants, bison, rhinoceros, deer, pig and other animals. The fruits perish rapidly and if they are to be sent to a distance should be carefully packed in dry sand or charcoal.

KURZ states that in Arakan this bamboo flowers every 30 to 35 years. The available data are however not sufficient to justify any definite conclusions. In 1930 fruits were offered for sale at Rs. 20 per 100, by the divisional forest officer, Chittagong Hill Tracts, Rangamati.

The growth of new seedlings is remarkable. By the first season each fruit will usually have produced four or five shots of which the latest may be as high as 10 feet. During the second season the largest culms reach a height of about 20 feet. By the fifth season the culms attain almost their maximum height. This bamboo spreads to remarkable extent by its long vigorous rhizomes.

The question of supplies consequent on flowering is thus not so acute as in the case of other bamboos.

VIII.—Neohouzeaua dullooa, A. Camus.

(*i*) *General description of the species.*

A middle-sized bamboo with culms growing in large tufts, often somewhat scandent, unarmed.

(*ii*) *Distribution and habitat.*

Bhutan 2,000 ft., Garo hills, Assam, Sylhet, Cachar, Chittagong, Upper Burma and according to GAMBLE Philippines.

(*iii*). *Growth and development of culms and clumps and artificial cultivation of the species.*

Culms erect 12 to 30 feet tall, whitish below the nodes ; nodes hardly prominent ; internodes 16 to 40 inches long with thin walls. Culm sheaths varying in size according to the internodes, striate, with scattered white hairs, prominent above, rounded at the top, concavely truncate and loose-fringed with stiff bristles ; ligule prominent, long-fimbriate.

Information about artificial regeneration is lacking.

(*iv*) *Methods of felling and extraction.*

The usual method of felling on a selection basis on a cycle of 3 years will be suitable.

(*v*) *Particulars about flowering and seeding and the effect of flowering on supplies.*

Information is lacking.

IX.—Ochlandra tramancorica, Benth.

(*i*) *General description of the species.*

This is the elephant grass, an erect tufted reed-like gregarious bamboo. It has very large fruits 2 inches long and long-beaked. The species possesses the longest fibre and has given the largest yield of pulp.

(*ii*) *Distribution and habitat.*

Found in the ghats between Travancore and Tinnevelly at 3 to 5 thousand feet, covering immense areas.

(*iii*). *Growth and development of culms and clumps and artificial cultivation of the species.*

Forms impenetrable thickets with culms 6 to 20 feet long and 1 to 2 inches in diameter. Internodes 2 to 5 feet long, walls thin. In Coorg it is a pest and efforts are made to exterminate it by cutting, burning and uprooting.

(*iv*) *Methods of felling and extraction.*

There is little information on this species, though from its nature it seems best to work it by clear-felling and replanting where necessary.

(*v*) *Particulars of flowering and seeding and the effect of flowering on supplies.*

Noticed in flower in 1882 by BRANDIS. It is believed to die down after flowering.

X.—Oxytenanthera nigrociliata, Munro.

(*i*) *General description of the species.*

A densely tufted, evergreen, gregarious bamboo. The black-fringed spikelets and naked auricles of the culm-sheaths distinguish this species.

(*ii*) *Distribution and habitat.*

Found in Orissa, Garo hills, Chittagong, Burma, the Andaman islands, Nicobars, Singapore, Malaya peninsula, Sumatra and Java. Gregarious in the Andaman islands in semi-deciduous forest and along streams.

(*iii*) *Growth and development of culms and clumps and artificial cultivation of the species.*

Culms erect, straight, dark green, sometimes striped with yellow, 30 to 50 feet in length, internodes 18 to 30 inches, diameter 2 to 4 inches. Culm-sheaths 6 to 16 inches, densely covered with black hairs, which readily come off on the middle line, leaving two longitudinal hairy belts, apex 1½ to 3 inches wide, convexly truncate, blade triangular or lanceolate, shorter than sheath, with two small round auricles.

This species is easily propagated by cut pieces of culms with the sheaths on, which, if pegged down upon the ground, root at the nodes.

(*iv*) *Methods of felling and extraction.*

The usual method of felling on a selection basis on a cycle of 3 years will be suitable.

(*v*). *Particulars about flowering and seeding and the effect of flowering on supplies.*

This species often flowers sporadically.

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Grazing Problems in the Sub-marginal Lands

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G|114030|In., G|1114|In., G|2612|In., G|123404|In., G|34|In., G|33|In.

Summary: Figures are quoted to show that there is an over-all shortage of 246 % in the annual availability of concetrates for cattle in India. Similar shortage of production in roughage is 49.69 mill. tons, or about 28.5% of the present availability. The quickest way of increasing more roughage for the cattle seems to be a proper management of sub-marginal lands, which are defined, for production of fodder; this is also likely to reduce both sheet and gully erosion as well. The respective responsibilities of the Indian parliament and the state legislatures are analysed in respect of land-use legislation, quoting the position in the U. S. A.; as soil conservation is a matter of national interest the responsibility of the Indian parliament is very clear under the draft constitution of India, 1948. Land-use classes by slopes are suggested as a rough guide, for reserving 0 to 15% slopes for agriculture, 16 to 30% for grazing, and above 30% for forests. Four methods of improving sub-marginal lands are broadly referred to, which will not only increase availability of fodder, but also reduce soil erosion, at present rampant in the country. —**Author.**

Improvement in the quality and health of live-stock in India is admittedly essential for the agricultural prosperity of the country. On the capacity of plough-cattle depends the efficiency of cultivation. About 840 million tons of cattle manure (green) is produced annually by Indian cattle out of which about 33% or 280 million tons is estimated to be available for use as (green) farmyard manure, or roughly 1 ton per acre of cultivated land, the rest is either lost or burnt as fuel. Farmyard manure when it is not burnt, but used in the fields, adds to the increased fertility of the soil leading to an increased production of food crops. In improving the nutritive diet of the people an increase in the consumption of milk is the first step. In India roughly about 6.42 oz. of milk is produced per day per head of population while 8 oz. is the optimum. Generally speaking, therefore, on the health-and quality of the cattle depends the health and prosperity of the Indian agricultural community.

In 1920 the first all-India census of live-stock was undertaken. Since then five-yearly census figures are available. Table I shows the variation of live-stock in India since 1925.

Table I

Province	Number of cattle and buffaloes (in '000s)			
	1925	1930	1935	1940
Assam	5,786	5,662	5,982	6,496
Bengal	25,492	25,492	25,287	22,699
Bihar	20,728	21,308	21,308	15,456
Orissa				4,863
Bombay	8,481	9,416	9,961	9,734
Sind	2,327	2,379	2,635	2,376
C. P. & Berar	11,671	14,378	13,844	13,279
Madras	22,111	22,441	24,607	22,119
Punjab	15,232	14,293	15,841	15,414
United Provinces ...	31,046	31,460	32,462	32,469
N.-W. Province	1,091	1,024	1,038	1,033
Total (Br. India excluding minor administrations) ...	144,705	148,361	153,745	147,424

The figures are incomplete in respect of some provinces and there are considerable errors of enumeration; no definite conclusions are therefore possible; but the table shows the general tendency of an increase in number, between 1925 and 1935 and a decrease later during the 30's, when there was an agricultural slump. It may be assumed that the present number of live-stock in India is roughly 150,000,000 (including Pakistan).

In 1937, Dr. N. C. Wright examined the question of the improvement of the live-stock in India; before him the problem was thoroughly examined by the Royal Commission of Agriculture in 1928. The first action proposed by both was an improvement in the present methods of breeding by providing an adequate number of bulls of improved variety.

The question of appropriate and adequate feeding is admittedly more important than even breading, for deterioration occurs even in improved breeds without adequate feeding. Dr. Burns analyses the relative importance of different methods of increasing milk production as follows:—feeding 30%: breeding 15%; management 15% and disease control 15%. Assuming that the average live weight of cattle is 600 lbs, the daily requirements of dry matter per head will be about 13.75 lbs, out of which at least 0.75 lbs. per head per day should be provided in the form of concentrats, and the rest in the form of roughages. The total annual production of concentrates (e.g. seeds, oil-cakes, bran and pollard) in India is estimated to be 3.7 million tons, while the estimated annual requirement is 12.8 million tons, leaving an annual deficiency of 9.1 million tons or about 246% of the annual production. This figure, though not accurate, shows the magnitude of the problem to be faced if the existing live-stock population has to be properly fed.

The deficiency is equally serious in the supply of roughages. Table II shows the deficiency of roughages calculated by Dr. Burns by regions. His reign I, consists of areas with rainfall over 70" and comprises the whole of Bengal, Assam, and Coorg, and the western, coastal strips of Madras and Bombay. His region II has a rainfall of 30" - 70" and includes the whole of Bihar, Orissa, Central Provinces and United Provinces, and portions of Madras and Bombay. In region III, there is less than 30" of rainfall, and it covers the whole of the Punjab, North Western Frontier Province, Sind, Baluchistan, Ajmere-Merwara and Delhi, and portions of Madras and Bombay.

TABLE II

Region	Total bovine adults (million)	Roughages produced annually				Roughages required annually in million tons dry	Deficiency	
		Special fodder crops (million tons dry)	Straws (million tons dry)	Grasses (million tons dry)	Total (million tons dry)		In million tons dry	Percentage of Col. 6 upon Col. 7
1	2	3	4	5	6	7	8	9
I	25.8	0.91	16.1	13.85	30.86	46.24	-15.38	67
II	61.5	5.84	48.3	41.21	95.35	130.26	-34.91	74
III	19.5	12.78	22.8	12.68	48.26	47.66	- 0.60	103
Total	106.8	19.53	87.2	67.74	174.47	224.16	-49.69	72

It will be noticed that of the total deficiency of about 49.69 million tons, it is very heavy in Region II, heavy in Region I, and Nil in Region III, or very dry areas, which now mostly form part of Pakistan. All proposals for land utilization should therefore take into consideration this heavy deficit of roughage in almost every region of India. It is necessary either to produce an additional 49.69 million tons of roughages, which is 28.5% of the total availability of roughages, or no improvement of the condition of the existing number of live-stock is possible.

Special fodder crops contibute about 11.2% of the total annual availability of roughages. About 10.6 million acres were sown with fodder crops in 1942-43 out of which about 5.2 million acres was in Punjab and Sind, 2.6 in Bombay, 1.6 in the U. P., and the rest over other provinces in India. The total net area sown was about 215.9 million acres. Extensive production of such special fodder crops was, however, confined to regions that have since been transferred to Pakistan. (Russell in 1937 calculated that of the total area sown, about 16.1, 7.6, 3.2 and 1.7% was under fodder crops in the Punjab, Bombay United Provinces, and Central Provinces, respectively). Any large increase in production by increase of area under fodder crops is therefore likely to be slow. But attempts must be continued, without infringing upon the period and area of production of agricultural crops, to get as much special fodder crops as is possible, suitable for the climate and soil of the regions. In the case of straw, however, with an increase in area under food crops such as rice, wheat, and millets due to the present drive in "grow more food" campaign, there is likely to be a parallel increase in the availability of roughages from straw, which is responsible for almost exactly 50% of the total supply.

Grass contributes the next important quota (about 38.8%) of roughages, and any slight percentage improvement in the yield of grass will add considerably to the total availability of roughages. Grazing areas supplying grasses fall under two main groups: Forests, and cultivable waste. Table III below, according to Sir C. G. TREVOR in 1937, shows that "Forests" are only of minor importance as grazing grounds; for, only about 10% of the cattle of the five provinces possessing large areas of forests had access to forest grazing. As large areas in reserved forests are inaccessible, the intensity of grazing shown in Col. 5 of Table III tends to indicate a better situation than what it actually is in the nearby accessible and intensely grazed localities. Intensities of grazing on an area can be said to vary inversely as the distance of the area from the nearest cattle-pen. It is therefore twice as heavy on an area situated at half the distance of another area.

TABLE III

Province	Forest Grazing: Area of forest (Sq. miles)	Area of forests open to grazing (Sq. miles)	Live stock utilizing forest areas (in millions)	Intensity of grazing (acres head)	Non-forest Grazing: Live stock (in millions)	Area available (Sq. miles)	Intensity of grazing (acre shead)
United Provinces	6,000	4,000	1·3	2	42	31,000	0·47
Madras ...	16,000	14,000	2·2	4	41·3	51,000	0·79
Punjab ...	5,000	4,700	2·7	1·1	23	42,000	1·17
Central Provinces ...	19,400	17,000	3·1	3·5	13·1	30,000	1·46
Bombay ...	14,000	12,400	2·4	3·25	11·3	40,000	2·95
Total ...	60,000	52,100	11·8	2·8	130·9	194,000	0·95

Forest grazing is under the control of the forest departments of the different provinces, and is generally regulated by the issue of grazing licences, at a nominal annual fee, for grazing in blocks in reserved forests. When the control of certain easily accessible forests has been handed over to a "panchayat", there has been unrestricted grazing, and consequent deterioration of the area as a potential source of fodder and fuel supply. Sheet and gully erosion has been noticed extensively over such overgrazed panchayat forests. The fertile top soil has been removed, which makes it more difficult to improve the present conditions of the growing stock of both trees and fodder grasses.

It is, however, in areas outside the reserved forests, and situated between them and the intensively cultivated agricultural lands that one must search for this potential source of increased supply of fodder. These are broadly called "cultivable waste" or "submarginal lands", which it is un-economical to bring under plough under normal conditions of agricultural prices. Portions of these lands are cultivated for a year or two when the agricultural prices are high, or the intensive drive of the government under "grow more food campaign" attracts the cultivator to take an additional amount of trouble to bring sub-marginal lands under cultivation. Such Lands, generally revert to their original status of "cultivable waste" after a few years. The concept of "sub-marginal" lands includes lands that, if cultivated, would make erosion practically uncontrollable, unless costly anti-erosional measures are first applied on them.

According to the agricultural statistics of British India 1942-43, there are about 91,889,000 acres of uncultivated land excluding current fallows, which are generally used as grazing ground. Table IV shows the classification of area in India.

TABLE IV

CLASSIFICATION OF AREA IN INDIA BY LAND USES

Sl. No.	Classification.	Area (1,000 acres)	Percentage or Total.
	Area by professional survey	514,104	100
	,, according to village papers	513,277	X
1	Area under forests	68,153	13·2
2	Area not available for cultivation	90,580	17·6
3	Other uncultivated land excluding current fallows ...	91,889	17·9
4	Fallow land	45,882	8·9
5	*Net area sown*	215,928	42·0
6	Irrigated area	53,734	10·8

Not only for the increased production of fodder which itself is a sufficiently important justification, but also from the point of view of soil conservation, these sub-marginal lands require immediate attention. Uncontrolled grazing and unchecked cutting of timber from these lands is a serious matter because the mischief is not immediately obvious. A casual inspection of some of these "waste" lands will show frequent occurrence of sheet and gully erosion in varying degrees of intensity. In some cases the gullies have become deep ravines. The regions that require immediate attention can be roughly enumerated as follows:

(1) Narbada valley between Hoshangabad and Jubbulpore. Roughly an erea of about 200 square miles of good black cotton soil has been broken up into deep ravines due to denudation, excessive grazing, and absence of any soil conservational methods in the systems of agriculture.

(2) Areas in the Chambal and the Yamuna basins where ravine erosion is frequent.

(3) Undulating districts in western Bengal where sheet erosion is common due to excessive grazing and denudation.

(4) The 'problem' districts of Bombay, such as Sholapur, Bijapur, and Dharwar where sheet erosion is abundant.

(5) The upper regions of the Mahanadi valley in the Central Provinces.

(6) The ceded districts of Madras.

(7) Steep slopes of the Himalayan valleys in the Kosi catchment area in Nepal.

While the forest lands under the control of the forest departments are being carefully conserved by technically trained men of the forest departments in the different provinces, and the agricultural lands are being looked after by the agriculturists themselves with the advice of the agricultural department, there is no authority to think about and to take charge of these sub-marginal lands which are deteriorating rapidly. In a comprehensive plan for land-utilisation in India an appropriate system of management for these lands assumes great importance due, firstly, to the possibility of an increase of fodder and fuel from these lands, and secondly, to the necessity for control and rampant soil erosion which is constantly destroying our national wealth in lands. The direct effect of this excessive accelerated erosion is loss of fertility of the agricultural soil, waste of runoff in high floods, silting of river channels, frequency of high floods, meandering of river channels, increasing height of high floods, and increase of drought.

Under item 32 of List I of the 7th Schedule of the Draft Constitution of India (1948), shipping and navigation on Inland Waterways, declared by Parliament, by law, to be national waterways, as regards mechanically propelled vessels, is in the Union list; i.e. the Indian parliament under Section 217 has exclusive power to make laws with respect to this item. Similarly, under item 74 of List I, of the 7th Schedule of the Draft Constitution of India (1948) the development of inter-state waterways for purposes of flood control, irrigation, navigation and hydro-electric power is also an Union item. Though

water, agriculture, lands, and forests are included in items 20, 21, 24 and 27 of List II (State List) of the 7th Schedule of the Draft Constitution of India, (1948) * (under Section 226 of the Draft Constitution of India, (1948) the parliament has power to legislate with respect to a matter in the State List in the national interest. Conservation of soil is a matter of national interest and has been admitted to be such in the United States of America in the federal programme of agricultural adjustment. It is therefore desirable that the Union Government of India gives a lead to the States in respect of legislation on conservation of soil in all lands, including focal point of erosion in submarginal lands. This action is likely to increase production of fuel and fodder for the villagers, as its direct result.

The history of soil conservation operations in the United States of America, pioneer in this field, would perhaps be relevant for our purpose. The Congress of the United States of America, in an Act approved in April 1935, directed the Secretary of Agriculture to establish a Soil Conservation Service in the Department of Agriculture, to conduct a comprehensive national programme of control of soil erosion. Under this statute the Soil Conservation Service opened and operated hundreds of demonstration areas in many States, directed the work of Civilian Conservation Corps camps, and conducted co-operative erosion-control studies at many agricultural experiment stations. It was soon realised, however, that the problem of erosion could not be solved adequately by work in isolated areas alone, and immediate necessity was felt for State Legislation by which the farmers could organise themselves for co-operative action, to apply on their lands the erosion-control practices that they observed on the demonstration projects of the Soil Conservation Service. Accordingly the Congress authorised the Secretary of Agriculture to require the adoption of suitable state legislation as a condition of his spending federal money in any State for erosion-control work. Under this provision the Department of Agriculture prepared the State Soil Conservation Districts Law, which President Roosevelt recommended to the 48 State Governors for submission to their respective State Legislature in 1937. Immediately, in 23 States legislation was adopted more or less along the lines of the standard Act. However, in Montanna, Minnesota, North Dakota, and Nebraska the Acts, as adopted by their State Legislatures, do not make adequate provision for enforcement of land-use regulations. In order to avoid the pitfalls encountered in the United States of America, it would be desirable to have the Indian Parliament consider from the outset the desirability of having uniforn States legislation in the different Provinces for anti-erosional and land improvement measures.

Appropriate State legislation in all provinces on the lines of Bombay Land Improvement Schemes Act, 1942, and the Punjab Land Preservation (Chos) Act of 1900 would be desirable. It is only when powers are given to officers or associations by legislation that any progressive planning of land utilisation could be taken.

In formulating the main principles of land-utilisation in India the gradient or the slope, of the land can be taken initially as a rough guide. There is generally a correlation between the percentage of erosion and the gradient of the land for different land-use classes, provided the erodibility of the soil is not widely different. The effect of the slopes on erosion in the watershed of the Norris Dam in the Tennessee Valley is shown in Table V below:

TABLE V

Land use classes	Percentage of erosion for stores		
	Gentle (0-15%)	(Moderate 16-30%)	Steep over 30%
Crops	15	29	31
Idle & abandoned land ...	5	26	36
Pasture	15	22-3/4	26
Forest	9	5-3/4	7

In the United States of America it has been seen that for normal *conditions* of cultivation, the gradient of the maximum slope that could be allowed depends upon the local soil and climatic conditions. While in some places it may exceed 5% in others not more than 2% could be allowed. Even in these cases of every gentle slopes it would be desirable to introduce principles of soil conservation in cultivation methods, such *as contour cultivation, strip cropping,* and *rotation* ot crops. Above 5% and upto about 15% gradient, cultivation can be allowed only with effective anti-erosional measures, such as graded terraces with appropriate outfalls either of the absorbent or channel type, with contour cultivation and strip-cropping.

Bennett has stated that some soils could be cultivated with a fair degree of safety on slopes having a gradient of about 20%, specially in porous gravelly soils. On the other hand 1 or 2% gradient is stated to cause appreciable erosion in Knox silt loams. These distinctions with regard to slopes are therefore not sacrosanct. These should be applied with local variations. As a general rule we may expect that all lands with a gradient more than 30% should be under forests, with controlled grazing; such control may be applied in restricting the number of cattle to the limit of grazing possibility, or by rotational grazing to provide short period of rest for portions of the year to allow seeding of good fodder grasses, or by setting apart areas for grass-cutting. Such areas may be constituted into reserved forests, if of sufficient extent, or village forests, according to situation, for the supply of fuel and fodder to the neighbouring villages.

Areas in submarginal lands with moderate slopes that is 16 - 30% may generally be considered, maintained, and managed as grazing grounds with appropriate anti-erosional measures. All steps necessary to increase the production of fodder from such submarginal lands will have to be taken when appropriate legislation is passed by the State Legislatures.

In improving the grazing conditions in these submarginal lands with a slope of between 16 - 30% we may follow the methods in Montanna, United States of America where co-operative grazing associations have been organised under State Legislation. These associations are set up under an Act which states that their primary purpose is to be the conservation and improvement of grazing lands. Co-operative operation in the use of grazing lands of the area creates a mutual interest in improved management, and the association, through its business organisation, is in a stronger position to use legal means to combat trespass than is the individual.

The actual steps necessary for improving pastures on submarginal land are not difficult to suggest. There have been many experiments in different parts of India at different times. The first step will probably be an effective control of grazing over selected areas in the submarginal lands. It has been found that a full closure to grazing is also an effective check on erosion, and mere closure for a few years results in a profuse natural growth of grass quickly covering the soil in most places, as the first stage towards rehabilitation of the vegetative cover. This increase of the grass cover is responsible for stopping further accelerated erosion and reduction of runoff. It has been reported that in the Pabbi tract, the reclamation area of about 3,000 acres yieded a revenue of a rupee per acre for grass cutting in 1937, as compared with a grazing revenue of 1½ annas per acre for adjoining lands. The application of strict closure on all lands however is not immediately possible. After an initial period of closure the area could be reopened to a restricted grazing; otherwise, it has been seen in the United Provinces that worthless grasses like **Aristida Hystrix and Aristida depressa** invade the land to the complete disappearance of useful fodder grasses.

The second method of improvement of grazing in submarginal land may be by controlled grazing This control means:

(i) Restriction of the number of cattle to be allowed in the area to the limit of grazing possibility.

(ii) Rotational grazing to provide short periods of rest for portions of the area, and time to allow seeding for good fodder grasses. Periodical grazing in which long periods of rest alternate with comparatively long periods of grazing is also a suitable form of control in some localities.

(iii) Setting apart areas for grass cutting to tide over the long dry season.

(iv) Restriction of goat grazing and exclusion of goats from hill slopes.

The third method of improving submarginal lands may be by contour-trenching and contour furrowings. Contour trenches are intended to create favourable moisture conditions in the soil to hasten the restoration of the plant cover and to help establishment of new tree species.

Large areas of submarginal lands have been improved in Bijapur, Sholapur, and Dharwar districts of Bombay by contour trenches. Not only have good fodder grasses appeared due to increased moisture and restriction of grazing, but also the annual yield of grasses from such areas has increased ; the freshly introduced tree spices, such as **Neem, Cashewnut, Hardwickia binata** and **Cassia siamea** etc. with which the area has been planted, will afford fuel, fruit and small timber to the villagers in due course. Along with contour trenches, the existing gully erosion could be controlled by check-dams and the standard gully-plugging methods, devised in the Pabbi reclamation area. The effect of contour trenching and gully-plugging upon reducing the runoff, and therefore controlling the flood, has been noticed both in the United States of America and in the Punjab.

The last and the final method of improving grass land will be by stocking the pasture with better fodder grasses and forage. Considerable study and experiments are still required to discover a correct grass-legume mixture for pasturage under Indian soil and climatic conditions. Pasture grasses require a light loamy soil fairly well provided with manurial ingredients. They thrive best under an equable climate with frequent light showers well distributed throughout the year. Such ideal conditions are rare to find in India. Here experiments are to be conducted in search of drought-resisting fodder grasses.

In South India, the Kollukottai grass (**Pennisetum cenchroides**) has been found to be one of the best in composition, with rich herbage. Amongst exotic grasses, the government farms have popularized the **Guinea grass**, a native of tropical Africa and **elephant grass**. The land requires a good dose of cattle manure before planting out. **Guinea grass** is palatable to cattle, is highly nutritious, and yields about 30,000 to 50,000 lbs. per acre, while **elephant grass**, on the everage, gives 60,000 to 90,000 lbs. of fodder per acre. **Lucerne** or **alfalfa** (**Medicago sativa**) has been grown widely in western India for its protein-rich roughage. The crop requires manuring, as well as irrigation, and is expected to yield 50,000 to 60,000 lbs. per acre, though much higher yield has been recorded undcr optimum conditions.

From the point of view of erosion-resisting qualities the following species may be mentioned in order of merit, as found in the United States of America.

(1) Bermuda grass (**Cynodon dactylon**)

(2) Lespedeza grass (**Lespedeza sericia, Istriate L. Stipulata**).

(3) Clovers (**Trifolium spp**) Leguminous fodder

(4) Cow peas (**Vignia sinensis**)

(5) Alfalfa grass (**Medicago sativa**)

Kudzu Vine, a native of China, has also been found very effective in resisting erosion besides supplying profuse quality of fodder. It grows prolifically and runners frequently attain 30 ft. in one season. It may be a locally suitable species to grow under favourable conditions.

The report on soil-erosion in India by Dr. D. V. Shuhart gives a brief general idea of the extent of the problem in the country and the urgency of action to be taken. While his report deals with all lands, the present paper is confined mainly to the action to be taken in sub-marginal lands. If the steps suggested in this note are taken, not only with soil erosion be controlled but also there will be an appreciable increase in the availability of fodder and roughages for the existing number of live-stock in India. It is only when all the lands in India are producing to their maximum, and every square yard of ground is doing its duty of producing either an agricultural crop or a forest crop or fodder, and there is no further possibility of increasing the available fodder in the country, that we could think of reducing the number of cattle, economic or uneconomic,—a thought repugnant to millions of Indians.

The Fifth British Empire Forestry Conference, 1947

By S. N. Kesarcodi, Conservator of Forests, Working Plans, and Research Circle, Bombay, Poona.

G|018|Bo.—Because of constitutional changes a new name is to be selected to replace "British Empire Forestry Conference." The tentative venue for the SIXTH CONFERENCE is India, in preference to Canada, and India is requested to clarify the position by 1949.

Despite the not inconsiderable proportion of tropical forestry interests, the **Fifth Conference** focussed attention on forestry in temperate regions. To remedy this the suggestion to hold a preliminary conference for the former with a wider scope is propounded to include all world regions of the tropics.

This conference in keeping with tradition was styled the British **empire** forestry conference but in view of constitutional changes. adopted resolution XII which left it to the standing committee to select a new name, in consultation with the various governments, preference being given to the name "British—commonwealth forestry conference". Even after a change in the name the next conference will be known as the sixth of the series, though the first one under the new name.

It was also decided, despite the pressing invitation of the Canadian government, to give first preference to India as regards the venue for the next conference. In the discussion which led to this decision, it was clear that no one was prepared to assume that India would not remain in the British commonwealth, though newspaper reports on the statements emanating from Indian Leaders tended to exhibit little doubt about India's future position. It was brought out during the discussion that ordinarily preparations may have to be started three years in advance. Perhaps preparations thus long in advance were necessary in reviving a conference the continuity of which was broken by the war and it may be possible to start preparations much nearer the date of the next conference. Any way, a desire was expressed that India would make clear her position within two years from 1947 so as to make it possible for her to exercise her option or to make known to Canada, in time, to go ahead with her preparations. All indications point to the probability of the constituent assembly reaching a decision before the end of the year and its decision may also be influenced by possible new changes, mooted by the daily press on what exact authority one does not know, in the constitution of the commonwealth itself. Foresters in India must place themselves on the qui vive to receive the decision and the consequences that may follow.

The second aspect is of equal, if not, of greater portent to foresters in India. Numerically, attended (including associate delegates and guest delegates) or nearly one-third of all who although nearly half the delegates (counting only delegates) had interest in tropical forests, the problems of tropical forestry did not receive the attention that was their due. A combination of circumstances went to cause this—the venue naturally focussed attention on "temperate" forestry, the greater size and importance of the forests in the temperate regions within the British empire and the relatively stronger delegation which represented those regions. It was agreed that the fundamentals of forestry were the same anywhere and the conference did not need to discuss or reaffirm them and that the most useful service the conference could render was in shaping future policies and practical measures in the various regions of the commonwealth. It was recognised that the practical application of the fundamentals of forestry to tropical forests was a much more complicated affair than in temperate rigions, particularly because scientific forestry has not had a long enough run in the tropics. Tropical foresters assembled at the conference realised towards the close of the conference that their problems needed more prominence but it was too late to do anything about it. One idea which also suffered by being thought of too late in the day for any common decision to be arrived at, was to hold a conference of tropical foresters of the British commonwealth two years in advance of the general conference. India with the oldest scientifically managed and also perhaps the largest extent of tropical forests in the British commonwealth is naturally looked up to take the lead in the matter. It would be a pity, however, to limit the conference to the British commonwealth, for, the largest of tropical forests are in South America and some of the best managed ones are in the East Indies. The South East area would have been a good sphere to begin with but I would like to believe that, forestry, like peace, is one and indivisible and we could serve the world through forestry if we throw open the conference to everyone interested in tropical forestry.

Regeneration of the Fir Forests of Pir Pannal, Kashmir

A Retrospect and some Suggestions

BY SHER SINGH. (Instructor, Indian Forest Ranger College, Dehra Dun)

S|3|Is., S|5|Is. The demand for fir received a fillip from the two World Wars. Regeneration of the fir has yet not been resolved. Kashmir has taken the first step by putting it on the research programme. The note puts on record the known points relating to the type found between Gulmarg and Shopyan. The method of treatment is also discussed.

The regeneration of silver fir is an extremely interesting problem. Unlike deodar, and other valuable conifers, it has not received much attention in the past, but World War I and more recently II World War brought this fir to the fore, due to the extraordinary demand. Although this demand has since gone down, yet there is little doubt, that the fir has immense possibilities, hence regeneration of the fir which has not been solved yet must in any case be taken up seriously for future research. The Kashmir goernment has already done some valuable work in taking this problem in their hand, and assigning it to the research branch. Some experiments and observations have been already made. This note deals with the problem in that valuable tract of fir forest which lies fairly low and on comparatively easy slopes, beginning from Gulmarg on the one side, to Shopyan, and a little beyond, on the other side—a distance of about 50 miles—which has its own peculiar conditions and limitations. Other fir forests in Kashmir, as in Sindh, are quite different in their lie and in regeneration, being steep and devoid of regeneration. The object of this note is to place on record the personal observations of the writer, on revisiting these forests, in the course of two decades of work.

The Pir Panjal is the backbone of Kashmir, and it is this which encircles the valley from the south looking like a mighty China wall separating the Punjab from the valley beyond. Those who look at this formidable rampart from the plains down below in the Punjab are often misled by its precipitous slopes and cragginess which are so evident on this side of the Pir. The Kashmir side is quite the antithesis of what the southern side is : and this is true much more fundamentally than the stereotyped difference between the southern and northern aspects in hills. There is indeed, no parallel topographical feature like this in any part of the world ; for the Kashmir side of the Pir Panjal is verily like the softened, stream-lined edition of the Siwaliks which are known for their easy gradients and mellowed curves. Then, as now, this has appeared to be the ruling feature of this country as also of the forests which clothe these hills, and the writer feels that this distinction must be steadily kept to the fore in discussing the silviculture of these forests which are chiefly of fir (**Abies pindrow**). But for a little **kail** which may be be likened to a pendant hung on to these virgin forests, from below, the rest is one mature to over-mature mass of fir, which is practically pure, being free, as it is, from rhododendrons, oaks and other broad-leaved species so frequently met with elsewhere in India in such forests. And the question is very often asked as to how the fir had descended so low, up to 6,000' elevation which is, indeed, in marked contrast to its prevailing habits normally from 8,000' to 11,000'?

A second feature is the definite presence of the lower age classes in such profusion that one could almost say that the 'regeneration of fir is no problem' in these Pir Panjal forests of Kashmir. And yet generalizations such as these are, to say the least inadvisable. Nevertheless, the fact remains that but for mature forests, which are now uniformly mature and which have never been felled nor opened up, there is such abundance of regeneration in lower forests that have been somewhat opened up before regular working that one is simply overwhelmed with its abundance. One, therefore, naturally asks : the how and why of all this fir regeneration in the Pir Panjal ? In the early twenties, the writer had seen but the upper three-fourth of this remarkable Range, but in this tour I could see the remaining one-fourth which comes close to, and includes the Gulmarg forests. It was here that I came across most wonderful stretches of fir regeneration—running for miles—in which there are all age classes mixed up most beautifully,

and in which, there are excellent illustrations of what a normal selection forest should be like: Compt. 64 Gulmarg, inspected by us in this tour, is a typical illustration of the case in point. Here, you would find a flat contradiction of the oft-trotted theory that the **Skimmia laureola** is generally an indicator of poor soil conditions i.e. of soil which is either too wet or too acid for fir regeneration to come up. In one photograph of this compt: (already published in the I. Forester) fir regeneration may be seen man-high, despite plentiful **Skimmia** at the foot of the walker; the whole compartment is literally riddled with regeneration and it does one's heart good to have a look at this most wonderful fir forest. I will return to the question of undergrowth hereafter, but let us refer first to the above two questions; namely the marked descending of the fir in this part of the valley, coupled with exceptional regeneration of the same.

These two problems are, in my opinion, interconnected and they must be attributed chiefly—but not wholly—to the general lie of the underlying rock which here turns out to be a 'Karewa' a most characteristic feature of Kashmir geological formation. They are, as we know chiefly of lacustrine origin dating as they do back to the time when the whole of Kashmir was one big lake stretching to the foot of the high hills that surround the valley all around. Some of them are formed by the glacial varves in which case the lamination is very fine, indeed, comprising about 1,000 strata in no less than an inch of soil (1); but in other cases the deposits are clay inter-stratified with sand, loam, and a few boulders and it is these latter that predominate in the basin of Ferozepur Nala which drains Gulmarg Range. A further feature of these Karewas is that they all dip from the Pir Panjal outwards i.e. towards the valley, and it is concluded by geologists that the Pir Panjal (like all parts of the Himalayas) rose up after the formation of the Karewas. This upheaval has folded and tilted the Karewas to some extent, but for the most part, they still retain their exceptionally smooth, 'writing desk' outlines—sometimes called "orthoclinical" structure—which, in my opinion, has gone a long way to produce this novel climax formation, such as are these fir forests (N.B. The upper craggy portions of Gulmarg are outside and above. Karewa Level). Now, this special geological formation engenders the following effects:—

(i) efficient sustained moisture due to melting of perpetual snows above, and slow drainage below i.e. due to very low gradient. and (ii) comparative absence of periods or spells of drought, due to this continued presence of sub-soil moisture (ensured by snowbelt above). Last but not least (iii) the clayey nature of soil gives just the required wetness which the fir forest pre-eminently require; this would not be possible if, for instance, the soil were sandy or schistose as in Ramban and Bhaderwah divisions which latter, on the other hand, would favour deodar against fir.

We have, therefore, in these fir forests almost unique approximation of the circumstances which may be said to be somewhat ideal for the regeneration of fir. Add to this the cognate factors of the cutting off of the monsoon blast in summer, and its corresponding conversion into plentiful fall of snow in winter (due to this elevated barrage presented by the Pir Panjal) and we have the last items in the chain of circumstances so peculiar to this part of the country. Now we can return to the questions aforementioned, and reply that fir comes down to as far low as 6,000' because water comes down and 'sits', i.e. remains more or less permanently in the sub-soil (even as snow on the southern side is removed much earlier than on northern slopes) and, thus, fir comes down creeping to the very foot of these hills. There is but one more species which can compete with fir in this respect: it is the blue pine, which not only overtops fir but also lines it from below, as it does in the Zewra forest of Shopyan (Pir Panjal). Deodar requires better drainage. The reason for this i.e. **Kail** lying on either side of fir here is, of course, not the same in either case—it is found **above,** as **kail** seed is taken up, far and away due to its lightness; and it is found below at the foot of fir forest (where neither deodar nor fir itself will come) because of its higher 'adaptability' which its long taproot ensures; for this reason it taps deeper and well-aerated soil than the layer which the shallow roots of a fir would normally do; here at the extreme foot the fir will become choked with too much water and carbon dioxide or with both. For this reason, even in the Lolab valley, we find a recurrence of the same phenomenon i.e. fir and deodar are both lined with **kail** at the foot of the forest, and not with other coniferous species. Here down below deodar, like fir, would be choked out by deleterious soil conditions, because the foot of the forest is practically level and there is no drainage whatsoever, but drainage occurs on the light slopes (however low the gradient) in the Pir Panjal. Fir regeneration comes up abundantly

wherever there is enough seed and where there are no other adverse factors (mentioned below). Fir also invades **kail** for obvious reasons, and of this regressive succession—so common in ill-drained **kail** areas or under dark covers—many instances might bee seen in the outer Drang forests (Gulmarg). But this is in kail zone, not fir.

Effect of grazing on fir. It is the Gulmarg catchment area, elevation 9,000'-10,000' which must claim our special attention as this area has been very effectively closed in the past, and although the fencing has new fallen in many places, yet, I think, there are enough watchers to keep it still sacrosanct. i.e. free from all grazing. *And here we notice that* while the area closed is full of regeneration in all stages, yet the area outside, on either side, is devoid of all regeneration which is here conspicuous by its absence—and this for no other reason than heavy grazing and trampling, particularly by the horses and mules so abundant in this **Ilaqa** which is a marked feature of the country. One conclusion, therefore, is self-evident, viz., that for fir regeneration to come up, closure is an indispensable condition; no doubt, *light grazing could be permitted* **after** *the regeneration has had a start* but if grazing gets the upper-hand, no regeneration can come up whatsoever, as these environs of the catchment area clearly showed. There is some grazing in Drang forests too but it must be *light, it being rather away from villages,* but Gulmarg bears the very brunt of hard grazing.

Three stages in closed forest. Even in the closed catchment area we can differentiate three different conditions of fir regeneration :—

(i) It is the **sloping** sides of **nalas** and ravines which are far more covered with regeneration than the flats at the foot due to the want of drainage in the latter. Here humus was also less than below.

(ii) The 'wet' portions, in this area, have comparatively little regeneration, and, here ,we find luxuriant growth of **Viburnum foetens, Skimmia Laureola,** the buttercup which grows in abundance; **Valeriana wallichii, Dipsacus inermis,** wide mint, **Polemonium caeruleum, Trillium Govanianum, Actea spicata, Aninslea aptera,** and some species of willow (**Salix**). In *such places, regeneration* of broad-leaved species such as maples and horse-chestnut, particularly the former (**Acer spp.**), is coming up very well. This may be called the zone of 'decided wetness' and is found both along the **nalas,** and at the top; here the **kuth (Saussrea lappa),** wherever put in artificially is doing very well. Humus is very deep here : 6-9 inches deep.

(iii) The middling zone is that wherein is 'medium wetness' and here also fir regeneration is plentiful though not like (i) above. Here the species found are : the ubiquitous strawberry the Loniceras, a few Primulas chiefly **P. denticulata Berberis sp; Polygonatum verticillatum (safed musali)** : the violet which is abundant; and a little of **Delphinium denudatum**; and **Skimmia**; with both the maiden-hair fern and the braken; some **Impatiens** (but no **Strobilanthes**). It is in this latter type that we find some **Podophyllum emodi and Ttropa acuminata** which medicinal drugs occur in this fir zone while the **Kuth,** properly speaking, occurs above the fir area i.e. above 10,000. Humus is 2 inches deep or less depending on slope and aspect.

What is true of the Gulmarg catchment area—closed for the last 25 years—is probably true of other fir forest elsewhere i.e. the fir suffers from grazing and too much underground water just as much as it suffers from insolation, which is a formidable factor on all southern slopes, where fir comes up only when the snowline is reasonably near. On northern slopes, therefore, what is required is closure, removal of litter, fairly good drainage and perferably very even slopes as in the Pir.

IN RAMBIARA BLOCK (SHOPYAN RANGE)

P. B. I. Compt. 3. Effect of debris.

It was, however, the P. B. I. area in the basin of the Rambiare (C3) which attracted my attention the most; so also (2b) close by, which were worked close upon 20 years back and ever since; for only a fringe of the forest is being worked all this time, and the full compartment will take not less than a decade more yet to fell. In the first place, it was rather unfortunate that the whole of the compartment has not been available for observation as it has not yet come under regeneration feelings. But the area gone over already shows :—

(i) that over a considerable part of the area the fellings have been like 'final fellings' as regeneration below was plentiful, and all that was necessary was to remove the seed-bearers standing over regeneration : so far so good—it is this type of forest which meets one's eye below and gives one the complacent satisfaction that we very often have when we go over 'easy' forests, with plentiful advance growth. This is the predominant type here.

(ii) But I had seen some uniformly mature **fir** forests two decades back, in this area, with **no** regeneration underneath, and it was these **that** I looked for and now found, and unfortunately here there was some difficulty, **because** there was so much debris on the ground that no regeneration could come up. Here the **humus** must have been over 4" deep, with **many** feet of slash including any number of **logs** left by contractors lying jumbled up. The seed-**bearers** marked in places were close—not more **than** 30' apart, usually 20'—and under this dark cover, I could find the following 'wet' species, **Sambucus ebulus** which comes up as weed in open fir forests as also in closed dark forests, even on deep debris—indeed, it is the only species **which** grows on acidic soil, it is 'endemic' to Kashmir forests, and is an indicator of too wet **and** deteriorated soil conditions—**Caltha palustris**, **or** the marsh-marigold (white flowers), which grows in wet depressions only;

Viburnum foetens (or the ubiquitious **Guch**) under which the **Guchhis** (morels) grow;

Gerardiana heterophyalla;

Impatiens spp in plenty, chiefly **I. micrantheum**; **Polygonum verticillatum**: **and Actea spicata etc.**

In these places, the soil appeared to me to be **far** too wet and it requires efficient handling. **In** the first place, all debris has to be removed, **at** any cost and if the contractors have not **removed** it in the past, it should be compulsory **for** future contractors to leave their rejections **only** at the foot of the forest, and not on the **forest** floor—as even centuries of lying in situ **will** not be able to rot them; and the only **inevitable** alternative is a fire, in a dry year, which will come when we might expect it least and will kill all seed-bearers too. Compartment **3** Rb has an area of 650 acres, and advance growth is considered to be complete on about **600** acres, but this is not truly the case on spot, nor can things improve till this slash is somehow disposed. Only 500 rupees were spent on this compartment on—all silvicultural works, in the last 20 years including all sowings; but certainly **a** more respectable figure is evidently the desideratum to ensure thorough cleaning of the forest floor. In no other way can such 'islands' of missing regeneration be brought on par with **better** conditions prevailing elsewhere in these **forests**. Fencing of such bits is needed.

Again, wherever opening has been too wide, **as** at the foot of the forest, **kail** is coming up instead of fir, showing that the opening is really fit for a light demander. In this case (as in case of deodar) we have to be on our guard against too much opening as much as against too little opening; we have to strike the golden mean. On the suprs and ridges also, more **kail** is coming up, mixed freely with spruce, which is so close to **kail** in its light requirements. Usually it is pure. From what I have seen, I am not discouraged by regeneration conditions found in C2 and 3 Rb, for here the major portions are already regenerated well enough, so that the marking was really like a 'walk-over' and the few 'isles' that are still left, could be brought into line with the rest by artificial regeneration, coupled with disposal of the slash which was an essential part of the old plan but which requirement appears to have been eclipsed by economic considerations, though how could it have happened, even before the World War I when conditions were better, is not clear, as there is plenty of old litter of that period also. All slash must be burnt.

OTHER REQUISITES FOR FIR REGENERATION.

The Kashmir forest department has been concentrating its attention on fir, like deodar, and they have been able to find that like the latter, there are few good seed years in fir forest; hence for this reason alone, the regeneration period has to be sufficiently ample, say 30-40 years. This shows that nature takes long to recuperate the clearings made by man—this is particularly true of fir, and that for two reasons: in the first place, the growth of fir is very slow, particularly when it is already suppressed (which is a normal feature of these forests) and secondly, the seed that is fertile (viable) in the cone is very little (hardly 30%), and that is so only from the **middle-aged** seed-bearers. This shows that the old, overmature, seed-bearers become senile and are really too weak to be efficient as mother trees. This is a reason for **decreasing** the rotation paried to such time as can give suitable size seed-bearers, the trees being removed soon after; (say 6½' girth) as some trees also develop heart-rot later. The rot is more in wet forests of Indian than in Kashmir. This, however, necessitates more markets for fir and fortunately the War gave it the required stimulus as the fir shooks were then very much in demand; so does the fruit-box industry, apple-packing being much in demand in the valley. But the demand is limited. Fir is also burnt as fuel in Kashmir.

The nursery technique at Drang, and near about, shows that '2 plus 2 method' gives good results

i.e. the seedling remains for two years in the nursery and then is pricked twice before being transferred to the forest—all of which factors point to slow progress of regeneration (whether natural or artificial). But that it does come in time, with its good seed years, when the soil is in a receptive condition, should be obvious to those who have intimate acquaintance with these forests. Only it is necessary to amphasise that fir, like deodar, requires a clean forest soil, free of encumbering humus and slash, and good dark cover also in the initial stages, otherwise it will fail to come up. Weeds if present can do little harm i.e. by suppression but these must be weeded when once regeneration is established i.e. about 6" high. Fir where occurring side by side with the **Skimmia** must have certainly preceded the latter ; it can also come under light shade of the **Skimmia,** but not when the latter is too dense. Next to **Skimmia,** the **Sambucus** alone has to be feared. Weeds should, however, be cut before a good seed year, as in deodar. The soil must be exposed and litter burnt.

TREATMENT

The Kashmir forest department is returning to the selection system ; this is the only method for treating the high-level fir forests on very steep slopes here as in India. But when you have Forests of the type as found in the Pir Panjal, one will naturally pause and ponder : will the return to selection be justified? By all means make use of advance growth, where it occurs, as in deodar ; but what will you do to uniform fir—these forests have to be treated under some form of the uniform method of working ; here the selection method is out of question for the forest has grown uniformly already. Will it not be better to do strip markings against the sum, or better have here the group uniform method, the groups centering around advance growth or inducing the same. Much indeed, must depend on subsidiary silvicutural works i.e. preparation of soil, and removal of litter and if less than a rupee per acre is to be spent on such operations (as done hitherto) why blame the uniform system, or, for that matter, any system ? Proper execution of supplementary silvicultural operations e.g. removal of debris, and strict closure, is the very essence of " concentrated regeneration feelings ", and this is particularly necessary when the seed is not abundant, as in the case. The crux of the problem is that the seed-bearers kept are usually over-mature and these produce very little seed. Hence, forests that have become over-mature will not easily respond to natural regeneration, no matter whether the system used is the uniform or selection method—in such cases they will either have to be left as protection belt (i.e. if they are on higher slopes) or they will have to be regenerated artificially, if they are on lower slopes. But artificial regeneration is to be avoided wherever practicable, as it is costly. To do so on large scale is a counsel of despair. Selection system is often a guise for no system at all. In my *opinion, we can strike a golden mean, over* a considerable part of this area, if we concentrate now on :—

(i) Keeping only middle-aged (and not over-mature) seed-bearers ; some old trees may be kept for shade, if required, but seed-bearers to be less than 6' girth.

(ii) Clearing the commercial forest of all debris (even though it may be costly) : some money will also be required for effective closures. Which is a **sine qua non** of fir regeneration to begin with.

(iii) Sowing where necessary in all over-mature patches ; but otherwise depending on natural regeneration chiefly. Group system may be given a trial, also strips.

(iv) Keeping 30-40 years regeneration period and also by keeping the forest sufficiently dense, as this is a supreme essential not only to keep away the weed-growth but to protect the young seedlings which do need cover in early life ; without cover they will die. It needs shade and the group system will give the desire cover, lastly (v) by working around nuclei of advance growth, and opening them where the regeneration is established, and where this is not the case, making little gaps or openings equal in diameter to $\frac{1}{3}$ the height of dominant trees, so that only the midday-sun may be able to act on regeneration, and not the morning or evening-sun ; these will be made on group lines and not distributed uniformly. More seed may be, thus, expected than under selection. Burning of litter is necessary only in wet places where it is deep.

This method cannot be called this ' selection system '; it is a a compromise between the so-called selection and the concentrated regeneration system, and these good fir forests of Pir Panjal are truly treatable under some such system, rather than the stereo-typed systems of old. In other words, advantage must be taken of re-*generation where found, which* may be expected over about half of the area, where this is not the case (as in overmature forest) there is no

alternative but to sow artificially ; but over other parts approaching maturity there is nothing like opening in groups or in strips which must be against the sun. The fir is a shade-bearer and this is brought about by 'saucer-like' profile of are areas in which regeneration comes ; it is just this profile which the group system will try to conserve, enlarge and then bring on par with the rest of the forest, which having regeneration will be freed of cover at a much earlier date than is the practice at present. This is possible here (at least in the Pir Panjal) as it is so close to Srinagar, and bears the brunt of fuel supply.

THE FLORA OF THE KAREWA SERIES OF KASHMIR AND ITS PHYTOGEOGRAPHICAL AFFINITIES WITH CHAPTERS ON THE METHOD USED IN IDENTIFICATION (CONTINUED)

THE FLORA OF THE KAREWA SERIES OF KASHMIR AND ITS PHYTOGEOGRAPHICAL AFFINITIES WITH CHAPTERS ON THE METHOD USED IN IDENTIFICATION (CONTINUED)

Scientific Importance Of The Study

By Dr. G. S. Puri.

The Karewa flora is believed to have flourished in the regions lying towards the south-west end of the Kashmir Valley and on the adjoining mountain chains now called the Pir Panjal Range during the First Interglacial Period, and contemporaneously deposited in a vast body of fresh water known as the "Karewa lake" which probably occupied more than half the present area of the Valley at that time (De Terra and Paterson, 1929, pp. 224-225). The fossil plants discovered from the beds at all localities are identified by comparison with the living species. Broadly speaking, the Karewa floras, excepting a few species which, do not seem to match any of the living plants are modern in their generic as well as specific aspects; and quite a few fossil species are still represented in the present-day floras of Kashmir Valley and the adjoining regions in the Himalayas (there are a few species, which now occur in the Central Himalayas also.)

Before starting a discussion on the scientific importance of the Karewa floras it seems necessary to say a few words by way of introduction. It is generally agreed by botanists all over the world that plants are indicators of the environments under which they grow (Clements, 1920, p. 3 ; Clements and Goldsmith, 1924, p. 5) and that they are more sensitive to climatic changes than animals ; for this reason they may be considered to be more reliable, and even superior to animals in interpreting present or past climates. In drawing conclusions of past climates from fossil plants it is usually assumed that plant life in the past ages required the climatic conditions essentially similar to those required by their closely allied living genera or species at the present time ; and that the occurrence of a plant genus or a species over a wide stretch of area probably indicates uniform climatic conditions in that region, wheras its restricted distribution may point to the existence of localised climatic conditions. A fossil type which has a close specific relative possessing a sharply defined climatic requirements among the modern floras can serve as the best climatic indicator. It has already been stated that the Karewa floras are composed of fossil types, which are identical with the modern species ; therefore, the former may be considered as ideal climatic indicators. The physical and climatic conditions under which the fossil species now live, and their reactions to the changing climatic conditions, are known from the works of the systematic botanists cited in the foot note(1) ; they have shown that adjacent regions of the country where different climatic conditions prevail, support an altogether different vegetation. Changes in such factors as rainfall, humidity, direction of the winds, temperature, biotic agencies etc., etc. in a particular place would bring about great disturbances in the relation of the vegetation with the environments, and this would demand a wholesale migration of the existing plant communities from that area to more congenial and favourable habitats, failing which extermination of vegetation would result. The reactions of water plants to their environments are still more marked.

(1) Brandis (1906) see introduction
Champion (1936)
Collett (1902) see introduction.
Gamble (1902) see introduction.
Hooker (1904)
Hooker and Thomson (1855)
Lambert. (1933)
Sher Singh (1929)
Parker (1918) see introduction.
Stewart, J. L. (1874) see introduction
Stebbings (1923) etc etc.

Just as a modern grouping of species at a particular place provides a knowledge of physical and climatic conditions of their habitats, similarly a fossil grouping of species should indicate to a great extent the conditions under which they had been growing in the past. Based on this principle the palaeobotanists have reconstructed vegetation and have restored the physical setting from the study of the fossil plants. A few excellent reconstructions occur in Prof. Seward's book entitled "Plant life through the ages". To illustrate the way in which the study of the Karewa floras will throw light on the physical settings of the Kashmir Valley at the time when these floras flourished there, let us for the present examine only the water plants that have been discovered from the beds at numerous localities. The aquatic element of the Karewa floras, the modern species of which thrive to-day in fresh-water lakes and ponds at the altitude of 5,200 ft. in the Kashmir Valley, have been discovered from the fossil beds that lie as high as 9,500 ft. (Sahni, 1936) and 10,600 ft. (Middlemiss, 1911, p. 122) above sea-level. Prof. Sahni discussing the reason of their occurrence in such higher regions in a recent paper (**loc. cit, 1936**) argued that as the modern plants of the fossil species do not and cannot grow to-day in lakes, ponds or streams at such high altitudes on account of ecological and physiological reasons, (unless they have changed since those times) the present discovery of the fossil species here is due to the elevated position of the beds, which must have been originally deposited at much lower altitudes (about 5,200 ft. above sea-level) and later uplifted to the present altitude. Quite recently the author has supported the theory of the Himalayan uplift on the discovery of terrestrial plants (Puri, 1943, 1944 and 1947). The geologists (Middlemiss, 1911 ; Wadia, 1938, 1939 and De Terra and Paterson, 1939) have furnished direct proof of this elevation in the tilting and sloping position of the fossiliferous beds on the high slopes of the Pir Panjal Range and proved from their geological studies that the Lower Karewas have largely shared the "geologically speaking recent Himalayan uplift", which occurred at the closing phase of the First Interglacial Period. The studies on the land and fresh water mollusks by Prasad (1925) and on the fish-remains by Hora (1937) discovered from the Karewas also point to the same direction. Thus the palaeobotanical evidence which is based on the study of these floras furnished an additional support to the conclusions of the geologists and others.

To state it briefly, the present study on th picture of the different Interglacial Period regarding its vegetation, the climatic conditions the physical extent of land and water, the positio and height of the mountain chains and othe features of the Kashmir Valley. It will becom easy to gain an insight into the physical and clima tic conditions of the Valley during the epochs tha preceded (First Glaciation) and followed (Seconc Glaciation) the First Interglacial. De Terra and Paterson (1939) have recognised four Glacia Karewa fossils will afford a more or less clea and three Interglacial Periods from a study of the terminal moraines in this part of Kashmir. The Kashmir Valley must have experienced several alternating periods of cold and warm climates when the glaciers would have descended into the valleys or preceded to the higher regions. Naturally under slightly different climatic conditions during the three Interglacial Periods different kinds of floras would have flourished and have been deposited in some glacial lakes or streams. The plant life of the glaciated tracts would have been buried in the terminal moraines. A careful and extensive search in the Karewas would doubtlessly bring to light more fossiliferous beds belonging to different Glacial and Interglacial Periods and detailed botanical studies of the Plant-remains would give us glimpses of the vegetation of these periods. Similar studies can be conducted on the deposits lying on the northern slopes of the Valley (if they are found to be fossiliferous) and finally the floras that flourished on the two mountain ranges lying on the south and north of the Kashmir Valley during the Glacial and Interglacial Periods could be compared. By this method we can study a procession of floras that occupied the Valley and later migrated to other regions. Then with the available data on the Glacial and Interglacial Floras of the Kashmir Valley from the study of plant-remains, comparisons can be made with the Glacial and interglacial Floras of other parts of the world, and the Glacial and Interglacial Periods of Kashmir can be correlated with those of Europe, North America, Africa, Arabia, Central Asia and China.

De Terra (see Hawkes, Hawkes and De Terra, 1934, p. 7 ; De Terra and Paterson, 1939, pp. 232-233 ; and Sahni, 1936a) has recently discovered some stone implements in post glacial deposits at Pampur near Srinagar. These deposits overlie the upper Karewa clays. This important discovery makes the study of the Karewa floras much more interesting and important, and their study would undoubtedly help in solving the

problems connected with the pre-historic human culture in Kashmir and other parts of Northern India. Prof. Sahni (**loc. cit.**) in a short paper "The Himalayan uplift since the advent of man" has discussed this problem briefly, but a more careful search will doubtlessly provide materials for further elucidation of this important question. Thus, investigations on these remains will not only give results which will be important to the palaeobotanists, geologists, systematists and ecologists but will also solve the problems of arcaeologists and all those who are interested in early man and his culture.

To sum up briefly the present study will elucidate the following important problems :—

(1) It will give a clear picture of the vegetation during the Glacial and Interglacial Periods of Kashmir.

(2) A comparison between the past and present floras of the northern and the southern slopes of the valley will be brought out.

This study will also throw light on :—

(3) Past distribution and palaeoecological groupings of Kashmir and Himalayan forests.

(4) Physical and palaeogeographical conditions of the Valley during the different Interglacial Periods.

(5) The distribution of the coniferous forests of the Tertiary, Pleistocne, and the modern times in India.

(6) Climates of the Glacial and Interglacial epochs.

(7) A world correlation of the Pleistocene deposits.

(8) A world correlation of the Glacial and Interglacial Floras.

(9) Causes of the Great Ice Age.

(10) Recent Himalayan uplift and the problems connected with it.

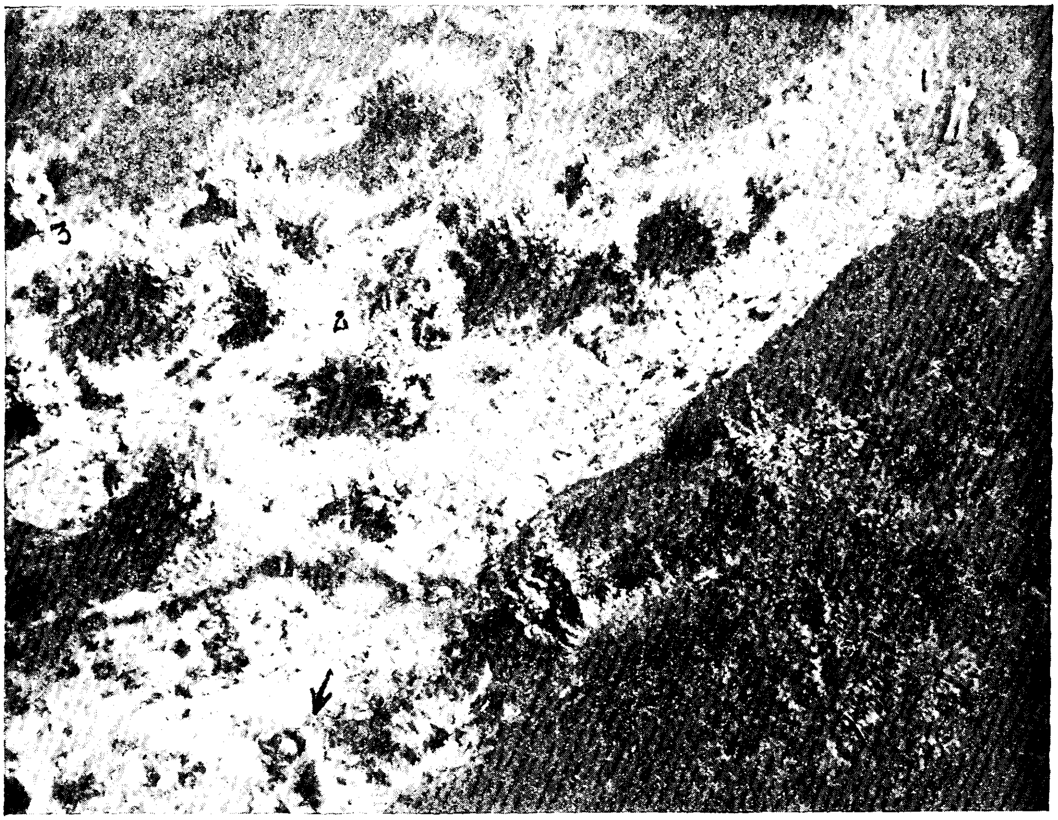
(11) The relation of the Himalayan uplift with the advent of man.

(12) The effect of the Great Ice Age on the plains of north-west India and its relation to the pre-historic human cultures.

PRINCIPLES USED IN IDENTIFICATIONS

It is needless to emphasize that the correct identification of the fossil species constitutes the most vital part of the present study. The exact interpretations of the past geographic limits of the valley, its past vegetation and climatic conditions under which the fossil floras lived, depend, as already stated, entirely upon the indications of the species composing it. The implications arising out of an inclusion of a wrongly determined species in the fossil flora become much more serious and the results are likely to turn out disastrous especially when one is dealing with an assemblage of fossil plants, which not only compares but is specifically identical with the modern flora. Several instances can be given to show that two or more species having a closely resembling foliage or other plant-parts occur growing in a very different climatic condition and a slight mistake, however trivial it may be, in the determination of the fossil by a comparison with the wrong species, may altogether upset the conclusions. An excellent example to illustrate such a confusion can be found in the spinous toothed leaves of **Ilex dipyrena** Wall., **Acanthus ilicifolius** Linn. and **Quercus Ilex** L. The first species is a tree of moist ravines, growing in the Himalayan regions towards east of the Indus between the altitudes of 5,000-8,000 ft. The second is a small shrub, which is commonly grown in plains as an aquatic plant in gardens; it is indigenous in India on sea-coasts. The last species **Quercus Ilex** L. a common oak of the N.-W. Himalayas, is a characteristic tree of the Inner dry Valleys distributed at the present time at an altitude of 4,000-8,500 ft. above sea-level. Superficially leaves of the three species look quite similar and do not disclose differences in detail of venation unless examined very closely. It is clear from the distribution of the three species how a wrong determination of several hundred fossil leaves, which in reality are foliage of **Quercus Ilex** L., as **Acanthus ilicifolius** Linn. would have given a different idea of climatic conditions and the altitude of the place of growth of the fossil flora in the Pleistocene time so the presence of this striking misfit, which has a low land distribution, among the fossil flora that will be found to be characteristic of the altitude of 6,000-7,000 ft. above sea-level, would have become difficult to explain if, due to a slight mistake on my part, it had managed to be represented in the list.

At first sight it may seem presumptious to identify fossil species by leaf characters alone, as has to be done with most of the material in such deposits as is found in the Karewas. Systematic botanists, even in dealing with living plants, usually desire flowers and fruits to ensure accuracy. Naturally, therefore, the identification of fossil impressions which invariably occur as detached leaves, often incomplete and ill-preserved, should present some difficulties to those, who attempt to refer them to their species on the basis of external characters alone. These


3
2
1


5

difficulties are not due to the absence in leaves of features, which can be used for specific identification but they are solely due to the lack of knowledge regarding their macroscopic characters.

Systematic botanists have laid all stress on flowers and fruits for separating the species while they give only minor importance to the leaves thinking them almost useless for systematic purposes. Among the books written on the Indian floras known to the author there is none which gives adequate descriptions of the leaves of the species described excepting " Flora of Assam " by Kanji Lall and Dass and others who have made an attempt to give salient features of leaves of some trees and shrubs growing in that area. Therefore, the remarks of such botanists on the uselessness of leaf characters for specific determination when they have not even cared to study them, will be wholly unjustified in the opinion of the author. On the contrary, those, who have actually studied the macroscopic characters of the leaves express views differently from those of common systematic botanists. The pioneer English worker Dr. H. M. Ward (1904) of Cambridge, who carried on studies in this field writes in the preface of his book " The leaf is the most plastic of all the organs of the plant, and it is by no means sufficient for the forest student to know the mere shapes of ordinary leaves, he ought to be familiar with the principal varieties, and especially with the metamorphoses which leaves undergo, and it is hardly too much to say that he who really understands the conformation and adaptations of the leaf, holds the key to the morphology of the higher plants". While describing the macroscopic characters of the leaves he writes at another place (p. 36) "......and the student should understand that not only does venation yield valuable species-characters, as we shall see further on, but that good service has been rendered to palaeontology by applying what is known regarding living species to the impressions of fossil leaves found in the rocks, and so at least helping the avoidance of error." Ward has probably derived inspiration from Ettingshausen's works (1861, 1871) as he has freely inserted in his book several photographs of living leaves from his papers. Ettingshausen's memoir (1895) on the venation of leaves of **Quercus** is an excellent work, and it reminds the author of the need for similar studies in India to facilitate the study of a lot of material of angiospermic leaves belonging to the Tertiary and the Pleistocene periods.

It becomes clear from the foregoing discussion that leaves possess certain macroscopic characters which can be used for specific determination both in living as well as in fossil condition. A a matter of fact most of our knowledge of fossil floras discovered from beds ranging from the Cretaceous to the Pleistocene Age in Europe America and Asia is based on leaf impressions which have been identified by a comparison of the macroscopic features of the fossils with living leaves. Chief among those who have employed these principles in the indentification of fossil floras composed of angiospermic leaves may be mentioned the names of Heer (1868-1883), Knowlton (1919), Berry (for a full reference to his works, bibliography at the end of Tertiary Period in Prof. Seward's book "Plant life through the ages" may be consulted), Chaney (1936), Mason (1939) and many others.

The above mentioned works of Heer and Knowlton contained many misleading results arising out of the wrong identification of the fossils (see Berry, 1930). They raised doubts in the minds of contemporary palaeobotanists, who were even led to question the validity of such a method of identification. Seward (1931, p. 431) raised this question in a masterly way; and writes," A very pertinent question often raised by botanists and laymen alike when they look at collections of fossil leaves is the possibility of accurate interpretation of the records: is it possible to distinguish one kind of flowering plant, conifer, or fern from another if the material consists for the most part of leaves and sterile twigs, and reproductive organs, which are the surest guides to affinity, are lacking?" Chaney (1938, p. 375) while criticising the work of Heer writes, "A classical example of erroneous interpretation arising from inaccurate systematic work may be seen in the results of Heer's studies of the arctic floras". Seward (1932, p. 431 also criticises the work of those students of the Tertiary floras who have described the fossils on the macroscopic character of leaves alone and charges them with **the greatest carelessness, which they have shown in comparing the fossils with the living material.**

This apparently means that the way of approach to the study of leaf impressions is not defective. This mistrust in the minds of others arose merely on the blunders of the earlier workers, who have not taken sufficient care in the study of such remains. Results of far reaching importance have been obtained by a score of palaeobotanists, who have successfully employed this method of study all over the world. The following words of Seward (**loc. cit.**, p. 431) affix

a stamp of authority on the potentialities of this method, "........**by careful attention to details and after as through a comparison as possible of fossil and living leaves, identification is possible**". Elsewhere on the same page he writes,"**Several palaeobotanists have shown that form and venation characters can be employed with satisfactory results provided the material is well preserved**". Chaney (1938, p. 376) too, places all reliance on this method and writes for those who disregard its application to the study of Tertiary and Pleistocene floras, in these words, "**The student of fossil plants, regularly faced with the problem of determining them from leaves alone, recognises distinguishing details of nervation and margin of which the average botanist is unaware**" (the italics are mine). He gives names of a number of Herbaria in America where one or more systematic botanists, who specialise in the identification of species from leaf characters alone are employed to carry on the taxonomic studies and give advice to those fossil botanists, who seek their help in the determination of fossil plants. The names of Merrill, Gleason, Wilson, Standley, Greenman, Abrams, Jepson, Mason and Setchell may be mentioned among the authorities on American floras in the leaf study. A suggestion may be thrown to those who are in high positions to employ such specialists in the Indian Herbaria to facilitate studies of the almost untouched wealth of remains of the Tertiary and Pleistocene floras which occur in the form of angiospermic leaf impressions in this country.

The author has derived most satisfactory results by following the same principles in the present study. In a few genera like **Berberis, Cotoneaster** and **Salix,** some of the fossil leaves could not be specifically determined because a sufficient amount of well preserved fossil material could not be made available at the present time; but in other cases the species are accurately determined my macroscopic characters such as the shape, the size of the leaf, the presence or absence of teeth in the margins, the kind of venation, the nature of midrib, the number and thickness of the laterals, their manner of origin and divergence from the midrib, the distance they keep between them near the midrib and near the margins, the distribution, the nature, the size and shape of the tertiary and finer reticulations.

In living as well as in fossil leaves, none of these characters, taken singly, may have much diagnostic value. Considering for an instance the character of margins, there may be a hundred and one species with entire margins and the number of those with serrate or crenate dentations may be still greater; so an attempt to separate the species with the help of this charter alone will lead us nowhere. Similarly any endeavour however, carefully made, for identifying living or fossil species with the help of any other single character must prove futile. Instead, the species can be accurately determined by the application of various combinations and permutations of the known features of leaves. The same method is applied by systematic botanists in determining species of modern plants from floral characters also. To illustrate the way by which this method can be successfully employed in determining fossil species from leaf characters, the fossil species of **Quercus**, described in another paper (see Paper 8 in the thesis) are selected to serve as an example; on the basis of leaf shape, margins and the nature of laterals the five species can be conveniently classed under two groups as follows:—

A. Leaves lanceolate, uniformly serrate, laterals running parallel and equidistant ————————————— **Quercus incane** (1)
————————— **Quercus glauca** (2)

B. Leaves of different shapes, entire or irregularly spinous-toothed, laterals neither parallel nor equidistant ——————————————— **Quercus semecarpifolia** (3)
Quercus Ilex (4)
Quercus dilata (5)

Each of the two groups can be tackled separately and the specific determination can be attained without much difficulty. Examining the species a little closely from group A it is found that the serrations in the margins are quite different in the two species and this character being constant can be utilised for taxonomic purposes. The margins are serrate almost to the base in **Quercus incana** Roxb., whereas **Q. glauca** Thunb. possesses the margins. which are serrate only from the middle. Similarly for separating species from the other group the criterion of thickness and nature of the laterals is sufficiently characteristic for systematic purposes.

Objections against this method may be raised and one may ask that as the macroscopic characters are not constant in leaves, therefore, a variable character cannot be considered thoroughly reliable for purposes of specific determinations. There is no doubt that reasonable variations in the various macroscopic features of leaf are of common occurrence in some species of living plants and one is likely to make a mistake in distinguishing these variations from normal types in fossil leaves. The size, shape and margins of leaves largely depend upon such factors as

the age, environment, and habit of a plant. Young spring leaves will naturally be smaller and thinner than old and mature autumn leaves, which not only become coriaceous with age but undergo a slight change in colour as well. The differences in leaf, size and shape due to diverse environmental conditions are so well known to botanists that they need hardly be discussed here. The margins also may vary a good deal in leaves of the same species and growing on the same plant and even on the same twig. In three species of oaks, namely, **Quercus samecarpifolia** Smith, **Q dilatata** Lindl. and **Q. Ilex L.**, which I examined in the fossil state as well as living, it is seen that the leaf margins vary a good deal according to the relative position of the branches from the ground. The leaves borne on lower branches of tall trees and all dwarf leaves and shrubby plant of the above-mentioned three species of oaks are coarsely cuspidate serrate, whereas leaves borne on higher branches have smooth margins. A different degree of dentation ranging from one toothed margins in some to a regularly serrate edge in other leaves is a regular feature witnessed in these trees. The foliage of these oaks is so notorious for possessing variations in shape, size and margins that if detached leaves from one and the same twig were to be found as fossil or even in a living state they might be identified with several different species and even genera by some, who have had not seen them in actual organic connection on the same twig in field or Herbarium. Such pitfalls occur rather too frequently in the study of fossil floras and a novice, who is not well versed in recognising variations is apt to be baffled by the superficial differences and resemblances that may occur in fossil and living leaves. A reference to the papers of some older workers of the Tertiary floras shows that several of them had been deceived by the superficial variations occurring in the fossil leaves, Knowlton (1902, pp. 39, 40 and see Chaney, 1925 pp. 8-9), while reviewing the works of Lesquereux and Newberry, who have examined the same material separately shows that the former author recognises among the variable fossil leaves of one species a few different genera, namely, **Quercus, Alnus, Betula, Carpinus,** etc., while the latter author combines all these genera into **Populus polymorpha;** later on these were correctly identified by Knowlton as **Betula heteromorpha.**

The Karewa floras, like other fossil floras which are composed of leaf impressions of angiospermic plants, contain a number of such species, the leaves of which show a different amount of variation. The author, fully aware of the fate of early workers, who committed blunders, has diligently endeavoured to keep away any error arising out of such variation by astudy of a very wide range of living leaves of the fossil species in Herbarium as well as in field. A detailed and laborious study for examining macroscopic features of leaves in the Herbarium was conducted for several months before the correlation of the fossils with living leaves was undertaken. The foliage of several thousand trees was examined during several excursions in the forests of Kashmir, Hazara, Murree Hills, Dalhousie, Mussoorie etc., conducted for the purpose of studying all possible variations in leaf characters. This extensive study revealed among others one thing quite interesting and the author feels that this needs a little mention here. The leaves of **Quercus dilatata** Lindl. growing in Kagan Valley, Hazara, are much bigger (about twice or even more, in size) than the leaves of those trees, which are flourishing on the outer Himalayan Ranges at Murree Hills, Mussoorie etc. It is interesting to note that all the fossil leaves belonging to this species, discovered from the various localities in the Karewas, are identical with the living leaves of the smaller size. Considering the climatic conditions under which the two types of trees of the same species live to-day, we find that the large leaved form, which is characteristic of the Kagen Valley flourishes in comparatively much drier climatic conditions, because the summer monsoons, which bring about heavy rains in Mussoorie, Muree Hills and other places in the outer ranges, become almost exhausted in reaching the former region. It seems clear that the difference in leaf size in the two forms is probably on account of the different environments in which they live, and that the small-leaved form flourishes in more congential places, while the broad-leaved form holds its sway in more adverse and trying environments; this shows that the latter form is the hardier of the two. What I want to point out here is that the broad-leaved trees probably belong to a polyploid form of the species, while those with small leaves may be diploid. It may be too much to express this opinion in the absence of any cytological eveidence of the two forms, but as it is known from the cytological studies of a host of workers that an increased number of chromosomes in a species often brings about a corresponding increase in size of all plant parts—the view expressed above that the broad-leaved form may be a polyploid form may not be considered altogether wrong. Sahni dealing with "Revolutions in the

plant world" in a presidential address to the National Academy of Science (1937, p. 57) remarks "......that an increase in the number of chromosomes goes hand in hand with a general quantitative increase in the body of the individual, expressed in the term gigantism. Thus compared with the diploid the tetraploid may be more robust, have a thicker and taller stem, larger leaves, larger flowers and larger seeds and pollen grains, even a larger cell size". Cytological studies by Hagerup (see Sahni, p. 56) on the plants growing under extreme climatic conditions have shown that polyploid forms are hardier than the diploids or tetraploids. Sahni expresses the same opinion in these words: "We have seen that polyploids, being on the average more hardy, often have a more northern and alpine distribution, or they may be better able to withstand extremes of heat and drought. It would almost seem as if any adverse conditions of climate may bestow hardiness upon a species" (p. 57). If some cytologist is able to show by examination that the two forms of **Q. dilatata** Lindl. growing in different climatic conditions in our country have a different number of chromosomes, it will not only be interesting but the evidence will furnish a very good example to cite with the following remarks of Sahni. "......, Chromosome increase is frequently expressed in a change in ecological behaviour and geographical distribution". It is particularly interesting that though such a great variation in other macroscopic characters occurs in leaves, the venation in all the variable leaves is constant.

For identification of the fossils in this study the following macroscopic characters of leaves have been utilised:—

(1) **Size:**— The size of different leaves in the same species is apt to vary on account of the reasons stated above, so this does not seem to have much systematic value. The fossil leaves described from the Karewa formations are probably those, which had been shed off by plants at maturity by natural causes and later got buried at bottom of the lake. Starting with this assumption the author has tried to compare them with average sized and mature living leaves of the fossil species, however, spring leaves were also not lost sight of. Sometimes to accommodate a fossil leaf in a given species, sizes of some 50 or more living leaves were measured and a mean size was calculated; in this way the error arising out of leaf size has been avoided. The measurements of the leaf size given in my papers are all in inches; this scale is followed because all the books dealing with living floras give the leaf measurements in inches.

(2) **Shape or outline:**— This too, like leaf size, is a variable feature. In most of the fossil leaves it had been possible to describe the outline by a single term but in a few cases compound terminology as ovate—lanceolate or ovate-oblong is used to give an accurate idea of the shape. In palmately divided leaves like those of **Acer,** the shape of the lobes is also given in addition to that of the leaf as a whole.

(3) **Margins:**— This feature, unlike the first two, is fairly plastic in most species, genera and even families. The different kinds of margins like entire, serrate, dentate, crenate, biserrate etc. are characteristic of different species. In some cases, when the venation was not well preserved in fossil leaves the margin characters have been very helpful in separating some of the genera, e. g., leaflets of **Rosa**, which have half serrate margins, were distinguished from leaflets of **Rubus,** which have complete regularly serrate margins. In some of the fossil leaves the margins, which must have been composed of delicate teeth in the living condition, have been found variously broken and this condition might easily give false ideas to one who is unfamiliar with living, leaves. As already stated the leaves of these three species of **Quercus** are exceptions to show a great variation in the marginal features.

(4) **Base and apex:**— These, too, are variable features. They are broken in many fossil leaves. In some leaves the base is so characteristic that one can readily identify the species even if the specimen may be badly preserved. The leaf of **Ficus Cunia** Buch-Ham. may be mentioned as an example of the latter case. The base is particularly helpful in finding out whether a fossil is a leaf or a leaflet. In the species of **Desmodium,** which have compound leaves, the base of the leaflets is always oblique, and there occur slight differences by which even the terminal and the lateral leaflets can be distinguished.

The apex also proves useful when dealing with fossil leaves of **Acer** sp. The species can be provisionally separated by an application of margin and apex characters of the lobes. But in quite a number of fossil leaves the apex is either altogether absent or badly broken.

(5) **Venation:**— This is the most constant of all the macroscopic characters of a leaf, so, it is of great systematic importance in specific determination of living as well as fossil leaves. One peculiar difficulty, which only the students of fossil plants have to face while dealing with leaf

impressions of the Pleistocene Age is, that the fossil leaves which are to be identified have undergone a different amount of change not only in appearance and texture but also in the degree of visibility of venation during fossilisation in waters of lakes or rivers. Therefore, on account of this unnatural appearance, which the fossil leaves acquire during partial or total rotting before preservation in lake waters, the identification by a comparison with the leaves, got fresh from the field or from the Herbarium sheets becomes a fairly difficult task. This false appearance which a modern botanist is not accustomed to recognise puzzles him the most and he expresses his inability to help a palaeobotanist in his study of fossil floras. The same fate was meted out to the author who after all has to resort in some cases to actual rooting of living leaves to about the same extent as found in the fossils so as to match the latter with the former in all details. The rotted leaves are photographed and pasted side by side with the fossils in a few cases.

Rotting of leaves though easily accomplished in nature in waters of ponds and lakes, is a somewhat difficult task to perform in the laboratory with an equal perfection. The following method was devised by the author in rotting the dried leaves from the Herbarium, which were kindly given to me by Dr. Stewart from authentic sheets. A few more leaves were got from the Forest Herbarium, Dehra Dun and the Royal Botanic Gardens, Sibpur. The dried leaves are first soaked in warm water for some time and then boiled for a few hours to make them soft. This treatment also extracted some of the chlorophyll and other dirty brown colouring matters from the leaves. The leaves are then boiled in alcohol for another few hours to extract as much chlorophyll and colouring matters as possible. Some leaves like those of **Populus nigra** Linn., **Desmodium latifolium** D. C., **Desmodium tiliaefolium** G. Don., etc. become absolutely transparent by this treatment and show the venation clearly. These need not be further treated but can be photographed as such. But most of the leaves still retain their deep brown, or black colour and do not show the venation unless treated further. They are now kept for rotting, which is accomplished by immersing the leaves in dirty water of some pond, or lake in a dish for a few days. The time required for the completion of the process varies from six weeks to six or seven months in different leaves. The first visible effect in rotting is on the cuticles, which get peeled off from one or both surfaces of the leaf in more or less regul[illegible] layers (Examples of this type are found in t[illegible] leaves of **Berberis caratophylla** G. Don., **Coton[illegible]aster bacillaris** Wall., etc.) or in tiny bits (as [illegible] leaves of **Salix Wallichiana** Anders., **Pyrus lana[illegible]** etc). In some leaves like **Deemodium gangeticu[illegible]** D. C.,**Parrotia Jacquemontiana** Done. etc. a[illegible] delicate matter of the leaf excepting the ha[illegible] skeleton of veins rots completely and a gent[illegible] rubbing of the leaf between the fingers brings o[illegible] the skeleton. The rotting in these leaves is com[illegible]pleted in three to five weeks. There are oth[illegible] leaves such as **Mallotus Philippinensis** Muell., **De[illegible]modium nutans** Wall., etc. in which the rottin[illegible] is accomplished in 8 to 9 weeks. The leaves [illegible] **Pittosporum eriocarpum** Royle., **Cotoneast[illegible] bacillaris** Wall., **Pyrus communis** Linn., etc ar[illegible] so delicate that with the rotting of the cuticl[illegible] the entire leaf succumbs into a gelatinous pulp mass.

In the case of oak leaves, which are ver[illegible] thick and coriaceous, one to two hours immersio[illegible] in 10-15% nitric acid helps to clear the venatio[illegible] but this treatment, as I found later on, injure[illegible] the finer reticulations, which completly dissolv[illegible] out in some cases. Even the weaker percentage of the acid, or an immersion for a lesser tim[illegible] is harmful and should be avoided.

The rotten leaves are photographed an[illegible] the photographs are pasted side by sid[illegible] with the fossils to show the similarit[illegible] between the two. The leaves are directly photographed on glossy bromide paper using differen[illegible] grades ranging from soft to extra contrasty pape[illegible] for different leaves. In some leaves (**Buxu[illegible] papillosa** C. K. Schn., and **Buxus Wallichian[illegible]** Baillon.) even an extra contrasty paper faile[illegible] to give nice black and white prints, so to ge[illegible] better results from such leaves extra contrast[illegible] developed * of the following formula was used—

No. 1

Hydroquinone............	1 ounce (25 gms.)
Patassium Metabisulphite..)	ounce (25 gms.)
Potassium Bromide..........	1 ounce (25 gms.)
Water up to..............	40 ounces (100 cc.)

No. 2

Potassium Hydrate (stiks).	2 ounces (50 gms.)
Water up to	40 ounces (1000 cc.)

The two developers are to be kept in separate bottles and mixed in equal quantity at the time of using. The same developer gives excellent

* (1) This formula is given on the cover of the box containing Ilford Process Plates

are referred to **Typha** and **Sparganium.** It is quite likely that, if better preserved material were examined, all the specimens may turn out to belong to any one of the two genera or some may belong to one, and other be referrable to the second.

Among the Karewa fossil two species of **Rubus,** two of **Populus,** one of **Betula,** and three of **Acer** do not seem to match any modern species now living in the Himalayas. It seems they have now become extinct from this part of India. They are described here as **Sp. A, Sp. B, Sp. C,** etc. and their affinities and comparison with other allied species are discussed.

In one or two cases, as in **Machilus** and **Salix,** the same fossil leaf resembles more than one living species and the author has not been able to decide as to its exact specific determination. In this case a very safe way is adopted; the fossil is described as **Machilus** sp. or **Salix** sp. and its characteristics have been compared and contrasted with both the living species in a tabular form. In such cases where one and the same fossil resembles more than one or two species so closely in the macroscopic characters that it can not be classed under either of these, then another important method is applied which not only helps in identification but also avoids the creeping in of any error. This is known as an ecological method of plant determination.

Different groups of plant genera and species at the present time live under different climatic conditions. The relation between a plant community and its environments are so rigid and well balanced that different plant genera and species growing together can be utilized in interpreting the climatic conditions or a fair amount of idea about the vegetation of a place can be had from the known climatic conditions prevailing over that area. This principle has been utillized by ecologists in classifying vegetation of the World into a few broad zones as Alpine, Temperate, Tropical and Subtropical. A complete list of references available on this subject is beyond the scope of this paper but a mention may here be made of well known work, e. g., of Schimper (1903) which chiefly deals with the vegetation of Europe and an excellent memoir by Champion (1936) entitled "A preliminary survey of the forest types of India and Burma" which is the first of the kind written for the whole country. A few more works of the same nature dealing with limited are those of Kurz (1877), Stamo (1925), Cowan (1929), Osmaston (1922) and Bor (1938. Troup's (1921) book on "Silviculture of Indian trees" is another work of the type of Champion.

Palaeobotanists have derived full benefit from studies of ecologists and systematic botanists and have utilized with advantage the knowledge of the modern plant distribution in determination of fossil plants. Chaney (1925, p. 10), while discussing the usefulness and potentialities of this method about 16 years back, expressed the opinion, "....that the taxonomic considerations of a fossil flora are inseparable from the ecologic considerations, since the known facts of modern plant association serve as one of the principal basis for determining fossil plants". He criticises the works of Heer and Lesquerex, who have neglected the ecological aspect in determination of fossil plants from leaf impressions. They have hopelessly mixed the tropical and subtropical elements with temperate genera and have put forth misleading and erroneous conclusions which were based on their incorrect lits of species regarding climates of former times; Chaney (**loc. cit,** p. 5) makes the following remark about their works:—"(Hear and Lesquereux) appear to have been handicapped by a lack of knowledge of the distribution of modern plants. As a result it was their practice to recognise in their European or North American floras many genera based on leaf impressions too often fragmentary, which have a modern range remote from the area furnishing the fossil". The author fully appreciating the importance of the determination of the fossil species and the relizing the implications, which arise out of the incorrect identification, adopted an over-cautious attitude from the very beginning; and a very careful study of modern species in field and Herbarium was supplemented with a thorough aquaintance with several groups of plants that flourish at different altitudes and under different climatic conditions at various places in Kashmir and other parts of N. W. Himalayas. Before the identification work was started a few lists giving all species that now flourish near the fossiliferous beds and other neighbouring regions in Kashmir, Murree Hills, Kagan Valley, Simla, Mussoorie etc., were prepared from the Herbarium sheets, books, unpublished lists of Dr. Steward and from the author's own observations in some of these regions. In identification an effort was made to compare first all the fossils with the species that now live near the places that have yielded the fossils. Some species were determined at this stage, the rest were then compared with species growing in all parts of Kashmir and all the fossil species thus identified are called Kashmir element. The remaining fossils were now compared to the species from the Kagan Valley and the Murree Hills, the

places which are adjoining territories of Kashmir on the north-west and south-west sides. Several other specimens still unidentified were then compared to the likely species from the floras of Simla, Mussoorie Hills etc. Fortunately, all fossil species with the exception of about a dozen specimens which do not seem to match any species from Himalayas and may belong to those species that have now become extinct from these region since the Pleistocene, are represented in the modern floras of the North and North-Western Himalayas. The application of this method excluded the possibility of an inclusion of an unlikely species in the fossil flora. The author feared that if any foreign species had been listed by little carelessness at this stage it would become increasingly difficult to get rid off it at a later stage, so this led him to take the most careful steps in identifications. At this stage after completely safeguarding himself against the wrong identification of any species due to a lack of knowledge of plant distribution, the author started comparison of the identified species with floras of a much wider range than that first used in the Forest Herbarium at Dehra Dun. All the likely as well as unlikely trees of the Western as well Eeastern Himalayas were now considered and compared to test the rigidity of the identified fossil species. All possible comparisons were tried but, much to the satisfaction of the author, the previous identifications held good in all cases. A consideration of the ecological grouping of the fossil plants also confirmed the identifications and there was not a single fossil species which could not be fitted into the ecological picture indicated by the Karewa flora as a whole.

LIST OF THE SPECIES

The species constituting the Karewa flora as at present known are distributed in 22 orders and 34 families of flowering plants (in Hutchinson's system of classification).

Class .... Angiospermae
Subclass .... Dicotyledoneae
Division .... Archichlamydeae

Order——Laurales
Family——Lauraceae
Machilus odoratissima Nees.
Machilus Duthiei King.
Phoebe lanceolata Nees.
Litsaea lanuginosa Nees.
Litsaea elongata Wall.
Order——Ranales
Family——Ranunculoceae
Ranunculus sp.
Clematis sp.
Family——Ceratophyllaceae
Ceratophyllum sp.
Family——Nymphaeaceae
Nelumbo uncifera Gaertn.
Order——Berberidales
Family——Berberidaceae
Berberis ceratophylla G. Don.
Berberis sp. A.
Berberis sp. B.
Berberis sp. C.
Order——Saxifragales
Family——Saxifragaceae
Itea nutans Royle.
Order——Lythrales.
Family——Onagraceae (Oenotheraceae)
Trapa natans L.
Trapa bispinosa Roxb.
Family——Lythraceae
Woodfordia fruticosa (Linn.) S. Kurz.
Family——Halorrhagaceae
Myriophyllum sp.
Order——Pittosporales.
Family——Pittosporaceae.
Pittosporum eriocarpum Royle.
Order——Euphorbiales.
Family——Euphorbiaceae
Mallotus philippinensis Muell.
Order——Rosales.
Family——Rosales.
Prunus cerasoides D. Don.
Prunus sp.
Pyrus Malus Linn.
Pyrus communis L.
Pyrus lanata D. Don.
Pyrus Pashia Buch-Ham.
Pyrus sp.
Rosa Webbiana Wall.
Rosa macrophylla Wall.
Cotoneaster bacillaris Wall.
Cotoneaster micraphylla Wall.
Cotoneaster nummularia Fisch.
Cotoneaster sp.
Rubus fruticosus Linn.
Rubus Sp. A.
Rubus sp. B.
Spiraea sp. A.
Spiraea sp. B.
Order——Leguminosae.
Family——Papilionaceae (Fabaceae)
Desmodium podocarpum D. C.
Desmodium laxiflorum D. C.
Desmodium tiliaefolium G. Don.
Desmodium latifolium D. C.
Desmodium gangeticum D. C.
Desmodium nutans Wall.

Desmodium sp.
Indigofera hebepetala Benth.
Indigofera sp.
Order——Hamamelidales
Family——Hamamelidaceae
Parrotia Jacquemontiana Dcne.
Family——Buxaceae
Buxus papillosa C. K. Schn.
Buxus Wallichiana Baillon.
Order——Salicales.
Family——Salicaceae.
Salix Wallichiana Anders.
Salix denticulata Anders.
Salix tetrasperma Roxb.
? **Salix acmophylla** Boiss.
? **Salix vimininalis** Linn.
Salix sp.
Populus ciliata Wall.
Populus nigra Linn.
Populus sp. A.
Populus sp. B.
Order—Fagales.
Family——Betulaceae.
Betula utilis D. Don.
Betula alnoides Buch-Ham.
Betula sp. A.
Alnus nepalensis D. Don
Alnus nitida Endl.
Family——Corylaceae.
Carpinus faginea Lindl.
Carpinus viminea Lindl.
Corylus ferox Wall.
Family——Fagaceae
Quercus semecarpifolia Smith.
Quercus dilatata Lindl.
Quercus Ilex L.
Quercus glauca Thunb.
Quercus incana Roxb.
Order——Urticales
Family——Ulmaceae.
Ulmus Wallichiana Planch.
Ulmus laevigata Royle.
Ulmus campestris Linn.
Ulmus sp.
Family——Moraceae.
Ficus Cunia Buch-Ham.
Celtis sp.
Order——Celastrales.
Family——Celastraceae
Elaeodendron glaucum Pers
Order——Rhamnales.
Family——Rhamnaceae
Rhamnus virgatus Roxb.
Rhamnus purpureus Edgew.
Berchemia floribunda Wall.
Sageretia oppositifolia Brongn.
Family——Ampelidaceae (Vitaceae).
Leea aspera Wall.
Order——Rutales.
Family——Rutaceae.
Skimmia Laureola Sieb. et Zuco.
? **Toddalia aculeata** Pers.
Order——Sapindales
Family——Sapindaceae.
Aesculus indica Colebr.
Family——Aceraceae.
Acer oblongum Wall.
Acer pentapomicum J. L. Stewart.
Acer pictum Thunb.
Acer Caesium Wall.
Acer villosum Wall.
Acer sp. A.
Acer sp. B.
Acer sp. C.
Family——Anacardiaceae.
Rhus punjabensis J. L. Stewart.
Rhus Cotinus Linn.
Rhus succedanea Linn.
Rhus sp.
Lannea Woodier Roxb.
Order——Juglandales.
Family——Juglandaceae.
Juglans regia L.
Engelhardtia colebrookiana Lindl.
Division——Metachlamydeae.
Order——Umbelliflorae.
Family——Cornaceae.
Cornus capitata Wall.
Cornus macrophylla Wall.
Marlea chinensis Lour.
Family——Araliacae.
Hedera Helix L.
Order——Myrsinales.
Family——Myrsinaceae.
Myrsine semiserrata Wall.
Myrsine africana Linn.
Order——Logoniales.
Family——Oleaceae.
Fraxinus excelsior L.
Fraxinus xanthoxyloids Wall.
Syringa Emodi Wall.
Olea glaudulifera Wall.
Order——Rubiales.
Family——Rubiaceae.
Hamiltonia suaveolens Roxy
Randia tetrasperma Benth.
Wendlandia exserta D. C.
Family——Caprifoliaceae
Viburnum Cotinifolium Don.
Viburnum stellulatum Wall.
Lonicera quinquelocularis Hardw.
? **Leycesteria formosa** Wall.

Order——Asterales.
Family——Compositae
Inula cappa D. C.
Sub-class——Monocotyledonae.
Order——
Family——Typhaceae.
Typha sp.
Sparganium sp.
Class——Gymnospermae
Order——
Family——Coniferales.
Pinus longifolia Roxb.
Pinus excelsa Wall.
Abies sp.
Cedrus Deodara Loud.
Picea sp.

(To be continued)

Eupatorium Odoratum Linn. as a Fish Poison

By M. V. Edwards
(Burma Forest Service)

S|OBu., G|92-fish poisons|Bu—It is pointed out that the fish poison known as **bizat** in Burma is **Spilanthes acmella** and not **Eupatorium odo-ratum.**

Fish poisons have been matters of considerable interest in recent years on account of their use as sources of insecticides, fôr which there has been a great demand. They were also the subject of enquiries by those engaged in jungle warfare as a possible means of increasing their food supply by quick and silent means.

Rodger, in his **Handbook of the Forest Products of Burma** states that **bizat** (**Eupatorium odoratum** Linn.) is used in Burma as a fish poison, and this, if correct, is a matter of some importance, because **Eupatorium odoratum** is a scrambler of Mexican origin which has spread widely all over Burma, both in the forests and especially in waste land. But it is curious that **Eupatorium odoratum,** which is well-known in India and elsewhere, has not been recorded by others as a fish poison, and it is very probable that it was only quoted as such by Rodger on account of confusion over the vernacular name.

The original **bizat** of Burma was the herb **Spilanthes acmella** Murr. and this name was quoted as long ago as 1852 by Mason in his book **Tenasserim.**

When **Eupatorium odoratum** began to spread in Burma it was called **taw-bizat** (jungle--**bizat**) from its resemblance to **Spilanthes acmella** but after a time as it became very plentiful the prefix was dropped and **bizat** became the common name. (It is also said to have been called **Kyamani-bin** or "Germany plant" because it was spreading rapidly over the country at the time of the 1914-18 war).

Kurz identified a Burma fish poison as derived from **Spilanthes acmella** (Mason, **Burma and its People,** ed. Theobald, 2 1883: p. 380) and Kirtkar & Basu say "Among the Mundas of Chota Nagpur the crushed plant is used as a fish poison." (**Indian Medicinal Plants, 2,** 1933: p.1367).

Following on Rodger's statement, **Eupatorium odoratum** has been included as a fish poison by recent writers on this subject, such as Raizada and Varma **Indian For. 63,** 1937: p.198) and Chopra and Badhwar* (**Indian J. of Agr. Soi. 10,** 1940: p.1, and **J. of the Bombay Nat. Hist. Soc.** 42, 1941: p. 854), but in the absence of further evidence it is necessary to omit **Eupatorium odoratum** and substitute the original **bizat, Spilanthes acmella** Murr., in the lists of fish poison plants.

Acknowledgements are due to the Forest Research Institute from whose records the above quotations were obtained.

* It is desirable to point out here that BADHWAR'S text uses the descriptions "recorded as poisonous to fish" and "stated fish poison". Hony. Editor.

Food, Fodder, Wood: Dry Cum Wet Farming Series

S|45|I.S., S|6301|I.S., G|1114|I.S., G|1215|I.S., G|123404|I.S.—The genesis of the Great Indian Desert is discussed and the features narrated. Dry farming conditions prevented plant introduction till Prosopis juliflora was introduction and spread with multiplicity. It is now hailed as the panacea for desert of the type met with in Jodhpur. Ecology and silviculture of the species are described in detail.

PROSOPIS JULIFLORA—The Californian Fodder-Bean-Tree, the fastest, cheapest, non-irrigated, surest Desert—Reclaimer and Rejuvenater, par-exellence.

Motto—"Grow more Food—Fodder—Wood:"Grow two where one blade once (or none) grew before".

By C. B. Gehlot, D.D.R. (Rtd. Conservator, Forests, Mines, Industries, via Jodhpur).

Introduction

THE GREAT INDIAN DESERT

Before proceeding with the subject—main, it would be advantageous to depict the salient features of the Great Indian Desert, where **Prosopis juliflora** is being propagated gregariously alone or in association with other desert species—**P. spicegera,** etc., with heartening success, to ameliorate the desert conditions.

SEA OF SAND

This Desert sea of sand, the ever-growing offspring of the Kathiawar and Rann-of-Cutch coastal and local sands, foraminifera, alkalies, salines, etc., burying portions of N. Gujrat, eastern borders of Sindh, more than half of Rajputana (diagonally from south-west to north-east) and fringes of S. Punjab, is, since ages, progressing, in fan-like form, north-eastward, further into Punjab and N.-W. Delhi and northern U.P., under influence of S. Westerly winds, mostly dry hot, blowing more or less violently and constantly during late winter, spring, whole summer and early and late rainy season.

BURIED SEA

Thus, an undulating sea-of-sand, more or less loose and mobile (being wind-driven) is formed and being formed,—in place of an ancient sea of water—(a receding armlet of the Arabian sea) covering, with hundreds of feet of deep dry and dreary sand and afertile land mantel, presumably rather evidently, a fertile land of alluvium studded with forest—clad hills and mountains, rich pastures and productive fields traversed by perennial rivers and streams, and lakes and lagoons interspread, all buried more or less deep, as indicated by fossils and archaeological excavation, etc., (e.g., Mohinjodaro, Kuhinjodro, Math, etc., Palana collieries).

GEOLOGY

Below and partly above the sand deposits, here and there, are hills, plateaus, mountains, and valleys formed of volcanic rhyolite, granite, ferrugenous and calcareous sand-stones, crystalline and nummulitic lime-stone, marble, schists, etc., with mud, mud-stone, slate and shales and chalk and conglomerates, now and then, scattered or in stretches.

WATER SCARCITY

Rains being scanty (4" to 12" average) and precarious, rain-water is scarce, insufficient and less to be depended upon even for drinking purposes. The well-water is hard, saline, varyingly deep—seated (200-300 ft. somewhere in dire mid-desert about 500 ft. deep) and available at long distances apart (10 to 15 miles or more), carried on camel. In some rare salt—impregnated localities the well-water is too brackish called "Bhereejna"—to be drunk to satiety even by cattle, to avoid poisonous effects.

IRRIGATION

Irrigation is out of question, being quite limited or possible only in oases or Bundhs, (dams), at hill-outskirts or along old buried river, stream courses and around lakes like "Sambhar" and other few water-collecting depressions.

CROPS AND FLORA

Rain-crops are the hardy **Bajra, pulses, etc.,** and drought resisting plants, pot-herbs of arid but useful type (**Acacies, Prosopis, Capparises,** etc.,) and hardy though very nutritious fodder and pasture grasses, however, grow and persist.

CLIMATE

Climate is healthy though severe, making men and all living beings, hardy, hospitable, sagacious, brave and resourceful.

FAMINES

Extremes prevail and often cause famines, scarcities, drought, pests (locusts), frosts, sand-storms, hot winds, scorching hot blasts called "Loo". Hence is the local saying "Famine" peeps into the doors of Marwar."

TEMPERATURE

Both diurnal and nocturnal temperatures range abruptly between long limits, both ways, sometimes causing blood-heat, rising to 120 F, in midsummer; and, frost and ice early and late, by freezing in midwinter, in open, over night,—sand being a good conductor and situations being naked and exposed to accelerate the severity of the weather. In January, the temperature falls to below freezing point during night.

FAUNA & FLORA CATTLE

Although some notable ancient species of wild Fauna and Flora have become extinct like the lion, wild âss, birds, sea-animals, etc. and dates, cocoanuts, the domesticated cattle—cows, sheep, goats, camel, cattle, horses, buffaloes, etc., and **temoca, melia, ficus, etc.** are still well-preserved and kept useful and famous for dairy, draught, conveyance, plough, and timber and shade and other economic purposes respectively. Still, degeneration has become inevitable owing to recurring famines, poverty and general backwardness and growing desert conditions.

BROWSERS, WORSENING DESERT

The browsers (camel and goat) especially are adding 'fuel to the fire', so to say, in respect of increasing disappearance and degeneration of natural vegetation, and worsening of desert conditions. But, they cannot, immediately be avoided or ousted from the rural population of the country, the camel being the "Ship" and goat the "Cow"—supplementary of the desert. The natural and artificial plants and fields crops no doubt receive a set-back from them. The following local saying well describes their depredatory habits and effects on vegetations. 'ऊँठ छोडियो आकरो-बकरो छेडियो काकरो'

The Camel spares AK (**Calotropis spp**) but the goat spares nothing except stone pebbles).

CRUX OF THE PROBLEM

The perplexity and burning question of the day, therefore, is "How best to maintain and increase the vegetation and production versus the two enemies above-named, meeting the requirements and prosperity of both at the same time, besides giving battle to sand-invasions to conquer the desert, so to say.

MAN—NO LESS A DEVASTATER OF VEGETATION

Here, man, too, can afford to show but little sympathy and safety to the vegetation of the desert, rather he adds to its devastation owing to his wasteful or uneconomic and ignorant ways of its exploitation rather over-exploitation which he has, unavoidably, to resort to, both in times of plenty and scarcity, the more so during the latter, when he is forced to cut remove or even root out trees, shrubs, herbs, grasses, etc. for food and feed for himself and cattle as famine-food. Besides, demands, for huts, fencing, firewood, etc., have to be constantly met from them.

EFFORTS IN AID OF VEGETATION

The governments, agriculturists, cattle farmers etc. are becoming conscious and enlightened, more and more, day by day; and, grow more food-fodder and wood-Campaign is being planned But so far it is like a drop in the ocean. Much has to be done or must be done, sooner the better, to keep the balance of production and consumption, well-maintained.

DRY FARMING

Therefore, foresters and reclaimers have been anxious, the more so, since forestry, here is mainly of dry-farming xerophytic, salinity-bearing, drought-resisting economic species.

RURAL-COMMUNITIES

The country people are agriculturists, cattle farmers and cottage industrialists (depending mainly on local forest products and minerals).

FORESTRY

Forests being the original source for all vegetation, *forestry must naturally occupy precedence* and front-position in combating sand and its concomitant troubles, on all programmes and plans for resuscitation. The fact stands:—"The more of forests the less of desert and vice versa."

TRIALS

Many a species—Indian, African, Australian and American, e.g., **Acacias, Cassias, Atriplex Casuarina**, etc., were tried but with little success, *till* **P. Juliflora** *came to be adopted and spread.*

MULTIPLICATION

Passing of the experimental stage was declared when **P. Juliflora had become a seed-producer,** *multiplying on a large scale in Marwar and*

some other states (Bikanir, Mewar, Bundi, (Deoli Cantt.), Ajmer—Merwara, etc.) in Rajputana, Bombay (Gujrat), C. I., etc., almost all from seeds produced, locally, in Marwar, etc.

NOMENCLATURE PROSOPIS JULIFLORA

Mesquite or Algaroba. Its economic name is the Californian fodder Natural Order bean tree, after the pods.

NATURAL ORDER

It belongs to the family **Leguminoseae,** genus—Prospopis of which there are two species—**Spicigera** and **Stephaniana** in India, this being the third. It is a native of Brazil and indigenous or cultivated and acclimatised in S. & C. America, California, Mexico, Texas, West Indies, etc., now naturalised in the Indian dry zones, Tropics and Temperate).

CHARACTERISTICS— IDEAL OF DESERT FARMER

Normally, these are —(1) Adaptive to dry even infertile mobile sands and soilless rocky boulders and dunes or saline areas. (2) Early Sand—fixer. (3) flood and wind erosion checker. (4) Drought, heat and wind resister. (5) Non-irrigational or water economiser. (6) Grower and spreader, both above and below ground (subsurface and deep-rooter) (7) Not an easy prey to, yet a supporter of browsers, too, (8) Good seeder and regenerator and self-grown-sown. (9) Strong ready and persistent recuperator (by stool and pollard shoots and root-suckers) despite injury, frost-bite, etc. (10) Prolific and early yielder of wood, fodder and edible or other economic products. (11) Ever-green and early and copious shade-giver. (12) Long-lived and tenacious. (13) Landscape beautifier.

Indeed, such a queer, complete and variously adaptive combination of qualities and powers is rare, but if available, is what the desert wants.

P. JULIFLORA PROVING IDEAL

How efficiently rather wonderfully, it fulfils almost all the above ideal characteristics, alone or in association with others, would be evident or understood from the description of its achievements.

EARLY IMPRESSIONS & EXAMPLES FRANCE

Atlantic coastal sand invasions, and their preventive and reclamation measures in mid-centuries gave birth to this branch of forestry, in the Gascony province of France.

AMERICA

Early settlers and missionaries did herculean tasks, in the past 2 centuries, of reclamation and rejuvenation in California, Hawaii, etc., deserts where **P. Juliflora** is believed to have played a magnificent part.

RAJPUTANA

Efforts to fix up shifting sand-inroads and prevent their increasing nuisance to the beautiful city of Jaipur, as well as reclothing of denuded rocky-cum-sandy desert around Ajmere and Beawer, brought forest conservancy to Rajputana during the seventies of the last century, where **Munj, A. excelsa, Acacias, Melias,** etc., were tried.

PUNJAB

The real and encouraging impetus and hope came when, in 1912-13, the Indian Forester brought to light the successful prevention of shifting sand-invasions and erosions near Attock, Indus, by **P. Juliflora** where other measures and species had practically failed.

FIRST EXPERIMENTS HERE

Later (about 1918-19) Messrs. Kunhi Kanan of the Mysore Agri. Deptt.) on research in America and R. B. Rangachari, (Lec. Bot., Agri. College Coimbatore,) strongly recommended it. Latest is from A. P. F. Hamilton, I. G. F. (I. Forester, March 1947).

VARIOUS ECOLOGICAL TESTS TRANSPLANTING

The writer promptly and happily picked it up as a long sought-after God-sent blessing to the desert. Seed obtained from Govt. Bot. Gardens, Saharanpur was sown in 1913 spring (February end) in the Central Agri. Horti. Forest Farm, Zhalra, Jodhpur, Germination was almost cent. per cent. Growth was excellent, the seedlings grew over a foot during 7 months. 200 transplants were put out at the close of rainy season in different soils, situations and conditions, mostly arid, trying, exposed to inclement desert weather and open to inroads of cattle and men, to test its hardy and persistant nature, with restricted irrigation.

DIRECT SOWING

A few seedlings were left in situ, to test comparatively direct regeneration.

Both methods proved successful. Naturally, however, the seedlings left in nursery seed-beds, owing to regular watering, deep soft rich soil and protection, grew so luxuriously that in six years

they attained fifteen feet in height and developed crowns matching their neighbours,—**Cordia, Zizyphus** of double the age. This proved that better tending and situation results in better growth.

HARD DESERT RECLAMATION

Thus encouraged, more seed was sown in forthcoming rains and. in branch nurseries around Jodhpur and scattered blanks. Hundreds of transplants raised were put out under more diverse and difficult sandy or rocky conditions in arboriculture and reboisement areas of Jodhpur and other ranges and scattered plantations.

HEARTENING RESULTS

Both by transplanting as well as direct sowing the plants grew well even without watering after a year or two, the seedlings of the direct method however germinated and grew only in prepared pits and in plentiful rain.

SELF-SOWN, SELF-GROWN

After 4 or 5 years, it became naturalised, self-sown and self-grown in favoured localities; and supplied seed in quantity for propagation.

VEGETATER OF INFERTILE FRESH STONE QUARRY DEBRIS

The first transplants were put out on Jagatsagar & Partapsagar quarries-Debris-mounds of sandstones, where not even grass and herbage would naturally grow, in 1912-13. The plants had to face the usual drought and browsing injury, in the ensuing summer. Irrigation was sparingly given. They did well and grew about double the size before the rains. And, the vegetative activity was so great during rainy season that the plants put forth a height growth up to 3 to 5 ft. Thereafter they were left to nature without watering. Plants continued to grow almost equal to those on dry sand-dunes. The browsers are chiefly the city goats, here. They stood well their attacks, firstly because their (goats) instinct did not allow to relish the foliage of a new species; and secondly, the foliage was neither attractive nor tasteful. But, the danger from axe of the firewood exploiter—the poor citizen began to play havoc from the third year onwards when the plants attained faggot size. The recuperative power of the species was so exuberant that it sprouted into vigorous shoots and long enough to yield thin faggots one and half to 2 inches, the next growing season to meet the demand of the greedy cruel cutter. Thus cut and recut and cut-back, the plants struggled hard surviving up till now (about 32 years since), some stool-shoots making head-way to about five to seven feet height with dwarfed crowns, with crooked branches and twisted stems, as escapes, the root systems and the under-surface stump, however, thickening to about one ft. diameter with contorted roots of restricted growth threading in between the stone gravel and ballast. No other species of trees or woody shrubs would grow so tenaciously and well in such situations and conditions. Its success here gave hopes of greater success in similar rocky desert or sand-dunes.

LITHOPHILOUS

The afforestation or reboisement of Chhitar Hill, where now stands the grand and strong, beautiful "Sri Umaid Bhawan Palace",—proved a baffling problem since the time of Maharaja Sri Jaswant Singhji (2nd). Several gardens and arboricultural species were tried at enormous cost and labour, but to no avail. The hill of naked solid sheet-rock horizontally disposed sandstone-massive and compact (with only fine cracks) as the Vindhyans are formed here, looked bleak and dry, as ever, and the planting operations were abandoned hopelessly. Emboldened by the trials of **P. Juliflora** as above-mentioned, it was given a trial, here too. A temporary nursery was established, where thousands of plants of this and other hardy companions,—**P. spicigera, Acacias, Ailanthus excelsa, Melia, Cordia,** etc., were raised and planted on the hill and its surrounding debris-mounds and sand-accumulations, taking advantage of the stone and **kankar-murram** pits and crevices in rock mass, here and there, making them wider or filling hollows, corners with debris, rubble and sand or earth, as available nearby. The plants were watered but sparingly as they were born of seeds of parents grown on the stone-debris-mounds described above, and were hereditarily lithophilous and acclimatised: and were believed to stand the situation better. The nursery-beds themselves were made on sheet rock sub-stratum with about one ft. of clay and sand mixture, to include lateral root system. Watering was given to seedlings only after the cessation of rains. The transplants, as was expected, did adapt well, and the operations continued for long, since, have now been successful to cloth the naked hill and its barren environs, well.

Its marvellous power of growing in even solid rock mass with only fine almost imperceptible cracks as in sandstone quarry mural scarps are exhibited in the overflow cutting and overhanging precepitous hill basement of city wall near Partap Sagar Jodhpur.

SHADES QUARRIES & EMBANKMENT

It grows even on thin film of fresh dust and debris of stone quarries with solid impervious rock bottom, so soon and so well forming thickets and umbrella-like crowns that quarrymen take shelter against the sun.

HALOPHILOUS CUM PELOPHILOUS

Marwar junction (B. B. & C. I.—JU. —U. C. Railways): here the soil being hard calcareous clayey **kankar** gravelly and saline with brackish hard soapy binding water, plants and trees generally do not grow well; this was tried with marvellous success. The parent plants (nursery-raised) did hold the soil and situation which was exposed to browsers and over-cutting, soon propagating by seeds and suckers forming family groups, after 5 to 10 years, of seedlings and saplings clustering round and dispersing far and wide by seeds carried long way by browsers. The once naked ground, all round and along the railway is now covered with thickets and seed-bearers and shade-givers. As a live-hedge around farms and courtyards and cattle-yards it proves efficient quick growing and ever-green, pleasant looking.

HALOPHILOUS CUM ARENOPHILUS

At Luni junction (J. Railway), (Hyderabad-Sind branch): the soil is loose sandy, more saline dry and shifting, and the water more brackish. It has grown higher with more fascicled without crowns, growing fast, irrigation, likewise shading, sand-fixing and beautifying the environs of the station and the line. Around the railway bungalows and quarters it has become high and protecting like wall. From this junction all along the branch line, at almost all its stations it has flourished likewise. The detentions of the trains was a recurring trouble and the planting and natural propagation of this and other hardy species has had good affect; and its spread further is desirable.

ARENOPHILUS SAND FIXER

Blown-sand, during dry hot summer, was a long standing menace to the town of Balotra on the leeward of broad (about half mile bed and high banks of) Luni river. Houses, cottages and Police **chowki,** etc., on the windward border of the town, used to be sand-buried wholly or partially in a few years' time, needing raised protective fencing or walling or shifting to safer sides, altogether. Protective plantations of **Melia, Acacia, Albizzia** were made; but, to little effect, really. This new comer was giving good hopes at above-named places, and with greater hopes, it came to the succour of the protectors and the protected. It has, during the past 25 years, grown to form a pure association of its own, or mixed with others above-named, fixing sand giving shade, shelter and beauty.

CALCIPHILOUS

Murram lime **kankar** hard-panned beds, naked or thin soil-covered, dry and impervious localities abound, especially at the base of or around hills and sand-dunes in this desert country. To clothe them with vegetation is a knotty problem. No tree vegetation except scrubs or brush wood bushes would take hold easily. **Presopis** has done well on such situations, too very well, of course, by sowing or transplanting, in pits filled with soft soil as at Chhitar hills etc., near Jodhpur.

WATER LOCKED ILL-DRAINED SITES

Murram deposits are excavated all over, for lime burning, and long series of pits and trenches are thus made and abandoned as water-logged or ill-drained spots. No trees would grow easily in such situations at least till refilled with soil sufficiently. **Prisopis** has done well here too.

SHIFTING SAND BINDER IN DIRE DESERT

On Phalodi branch of J. Railway, still more difficult sand trouble prevailed. Train detentions were more frequent and costly. Removal of sand, now and then, during hot dry months, had to be done by employing large gangs of labour. Between Lohawat and Phalodi where sand is quite fine, loose and mobile, is wind-blown like currents of water following close the rainfall was upon the crux of the trouble. Tree-growth was further checked by want of water for drinking or irrigation, the water being brackish or too deep and too far. The substratum is rocky and near surface in flat portion, and deep-buried under sand-dunes. These factors made the situations exceptionally adverse. Sand-fixing efforts were made here, too. The most hardy desert plants like **Acacia, Calotropis, Saccharum Saraetc,** were tried along with this tree. None did flourish even with little watering, except the last named, which persisted well.

AROUND XEROPHYTIC

By virtue of its fleshy liner small leaves, resinous, gummy starchy element in all **its** active organs and pods, its restrained stomatic transpiration and respiration, when dormant lateral as well as downwards spread of roots, its power of absorb-

ing atmospheric moisture and storage of reserve food material, it has assumed xerophytic nature befitting success in desert-life under varying difficult conditions.

ACCLIMATISATION

It has been found to become acclimatised in two generations after the local ecological conditions *have been well adapted and its regeneration* from its own locally produced seed has become self-sown and self-grown.

RE-GENERATION NATURAL & ARTIFICIAL

As has been observed it is an early and prolific seeder and regenerator by seeds, shoots and suckers, twice in a year the seed being protected by hard covering and the pod being edible is dis*persed by cattle and birds eating its pulp, far* and wide. The seedlings are hardy, and stand drought conditions well even from early stage, and being armed with spines are protected against browsers; nor is their foliage attractive or relishing, then. The great vigorous ready recuperative power makes it regenerate by stool-shoots, pollard-shoots and root-suckers, readily after injury from cutting, biting or trampling. The nursery raised plants are capable of standing transplanting *shock well after even half year's growth*, and become established soon with little watering for another six months or so, till favourable rains come to their aid. No doubt, the larger the plants the better, and the longer the irrigation period the greater the growth, especially under adverse conditions.

GERMINATION

Seeds eaten by and ingested in stomach, of cattle germinate well, and in only two or three days after sowing in situ or in nursery. Similarly, seeds soaked in water for 1 or 2 days germinate soon. Otherwise, the seeds take about a week to germinate if watered or soaked in situ by rainwater. Therefore, it is advisable to use the mature seeds collected from the excreta of cattle yards.

RECIPROCATIVE ECOLOGY

As described above, it is clear that itself being widely and elastically adaptive to natural ecological conditions, as available, makes the best use thereof or creates its own ecological congeniality after establishing itself firmly and extensively, by a well-maintained strenuous and irresistable process of sociability and creative power. So to say, it lives peacefully with its neighbours or associates of its own or others of like nature. It creates humidity in air and soil, it protects and is aided by them. It enriches soil for itself and others.

A LIVING EXAMPLE OF ITS HOSPITALITY

It is growing like twin-brothers with **Albizzia odoratissima,** for 30 years past, on Paota road—"Zalim Vilam", road junction, Arboriculture, Jodhpur, shewing normal growth of both living peacefully. Similar examples are found elsewhere, too.

LIGHT-DEMANDING CUM SHADE-BEARING

This is another good combination of qualities in it. Its light-demanding nature is evident from its power of standing insolation, exposure and growing fast in blanks and gaps. While, its shade-bearing nature is proved by its own seedlings, born under its shade and root-suckers underneath it as well as itself growing well under crown cover of others, **Melia** etc.

TENDING

It requires but little tending after transplanting or sowing direct except pruning of epicormic and other lower branches or adventitious out-growths to keep the bole clean straight and round. Its *crown branches if judiciously lopped or trimmed* would make the crown dense symmetrical and roundish umbrella-like. Thinnings would be necessary if tall or spreading high-growth be the desiderata. In case of live-hedges, successive toppings and lopping and trimmings would be needed. It is self protected against animals. Fire protection is seldom required. An ordinance has been issued to protect from misuse and overcutting.

NO DISTURBANCES

Wherever it is to serve as a blown-sand resister, wind-break, erosion-preventive or solid-sheet rock-area-reclother or such like, its root system may follow crevices, cracks, open exposure, holes, etc., and its crowns may spread out creep along or climb over or enter into and over surface, it should not be disturbed, or checked in any way, but they be allowed to take their best and easiest course to combat the situation.

HABITAT

The best habitat conditions comprise :— An open expanse, fine soft soil, deep sandy sub-soil, water not too deep (nearer the surface the better), a well-drained situation, protection from frost and violent wind storms, side-strips and high banks of **nullah** or river, silty sandy loam inundated plain and low-lying localities where it can

freely spread to form gregarious forest of its own or a mixed association with its sister—the **P. spicegera** and other desert plants— **Tecoma undulata,** etc., —Xerophytic associates.

RATE OF GROWTH

Transplants as well as the offsprings of direct sowings or self-sown, yearly grow, at an average rate of one inch to one and half inch in girth of trunk or boughs, and one to two feet in height and crown spread up to advanced pole stage and before reaching full maturity (about 20-25 years of age), 20 to 25 feet diameter of cover. When full mature it grows to about 5 feet in girth and 40 feet in height. Its regrowth from stools and boughs or thick branches looped or cut back or frost-bitten is tremendously rapid attaining large dimensions in a growing season or two, i.e., six to twelve months after: shoots five to ten feet long and one and half to three inches in girth are observed in favoured localities.

BOTANICAL DESCRIPTIONS

Briefly described, it is a large shrub to a large tree of varying nature and spread,—low spreading crown like a trailer, semi-erect or sub-erect struggling climber, a large straight clean erect round long boled trunk bearing a large spreading roundish crown made up of straight long branches growing out of thick boughs, producing a switchy tangle of thinner branchlets—drooping pendant, terminate twigs laden with bi-pinnate leaves, the pinnate being in opposite pairs bearing opposite pairs of leaflets giving the appearance of the crowns, like sweeping the ground. It bears a profuse inflorescence drooping like earrings or pendants from leaves, replete with honey-nectar, twice a year in autumn and spring. Likewise that is a double crop of pods indehiscent pale brown pendant, 5 to 9 inches long 1|5 inch broad one eighth of an inch thick or thicker if well nourished, containing about 1 to 2 dozens flat round brown seeds with hard glossy covering integument. The mesocarp of the pod is full of gummy starchy resinous hexa-tasteful syrupy pulp, edible by cattle and birds. The roots system is double, that is lateral as well as down going, some of the roots traversing long thread-like or thick rope-like according to the medium or strata passed through. The lateral roots lying horizontally near the surface bear adventitious buds that sprout into root suckers and terminal shoots to make independent individuals sooner or later, as required by exigencies of parental growth and regeneration or recuperation. Bark is thick, green to greenish brown to brick bronze to dark grey in colour from young to mature stages of growth respectively, mesodermis being reddish brown, the endodermits being pale white and the cambium being whitish grey full of whitish sap, almost always active. Bark strips off long easily, dry bark cracks lengthwise, flakes linear contain tannine.

ECONOMIC PRODUCTS

All its parts or products are useful or economic, directly or indirectly.

Wood is made up of hard wood about 75% when mature, straight-grained, fairly hard, strong crosswise, takes fair polish, exhibits chequered colour brownish to darkish red, splits lengthwise, sawn easily, suitable for small or medium sized furniture, domestic articles, agricultural tools, water-lifts, etc., Sapwood is whitish pale, fissile, fit for firewood (even green wood is cumbustible easily) but is liable to the insect attacks.

Fencing of the spiny branch wood is efficient for protection around fields, cattle-pens, dwellings, etc., against cattle and men.

For hut-making, (for roofing and partitions of huts) cattle-sheds, etc., it is easily adapted: watch-posts etc., are made of its thicker branches and boughs, so are the door-frames and gate-crates.

Fodder beans : its chief and valuable product are the ripe pods produced twice a year, in large quantity, one to two maunds a year per average size tree. They are greedily eaten by goats and donkeys and other cattle. Cattle-owners also collect and stall-feed them. The yield begins at 4 to 5 years of age. The raw green pods are not of food value. (Note :— It is suspected of causing an intestinal colic amongst cattle who eat it when raw, but concrete cases have not been detected.)

The pulp of the pods is of six tastes :— Sweet, bitter, saltish, acrid, acid and tannic. It is, therefore, nutritive, tasteful, curative and tonic food for the cattle, (Note :—It is reported to be efficacious in diabetic and other semen troubles). The sugary content might be a source of alcoholic production. Requires research.

Gum : It produces translucent gum, in balls or tears from its semi-mature trunk wood or thick boughs; it is mucilagenous enough, but its other properties are not yet ascertained.

Flowers : Last but not the least important are its flowers which are full of honey. The flowers appear and remain productive of honey, twice a year for about 2 months each time, and therefore, they fill up a great gap in honey producing flora of the plains. Both wild and semi-wild bees are

found to make hives in the crowns of this and other species and in fencing, nests and corners and eaves of high walls and roofs, in localities abounding in **P. Juliflora,** where before its advent or introduction none such hives were observed. The yield of honey per tree is to be ascertained. Its longevity is not yet ascertained. But, the individuals, over 30 years of age are still healthy and vigorous.

INDIRECT BENEFITS

These are :—Moderation of climate, increase of humidity and moisture in soil, helpful to health and growth of other plants, animals men, fixation-of-sand in desert, retention of subterrean flow of water and its gradual escape in springs, wells, etc. prevention of erosion on naked steep hill-sides and sand-dunes. Impregnation of the air with sweet mild fragrance almost all the year round, taming of flood water and torrential drainage courses, formation of flood screens, water-weirs. Nursing of other delicate forms of vegetation and animals.

AREA UNDER IT

It has so much spread over distant scattered plantations and self-grown forests that it is difficult to estimate the total area. But, it can be safely estimated to be now over a lac of plants as seed-bearers and wood producers and shade givers, planted by P. W. D. Gardens & Deptts. and the public and chiefly Forest Dept.

FINANCIAL ASPECT

Costs vary two to four per plant of 2 years. Rs. 5 to 15 per 50 plants for 2 years specially as the rates of wages, materials, plough, water supply, etc., are so much inflated fluctuating and exhorbitant that fixed cost data are difficult to arrive at. But, the average yield of net income is safely expected to be rupee one per year per fifteen years old tree. Therefore, as many lacs of rupees net income is estimated yearly, to state and nation as many 15 years old trees there are of it, at any time. But it being a self-sown self-grown gregarious species, now, it will be almost a free asset to the desert with little effort and outlay continued.

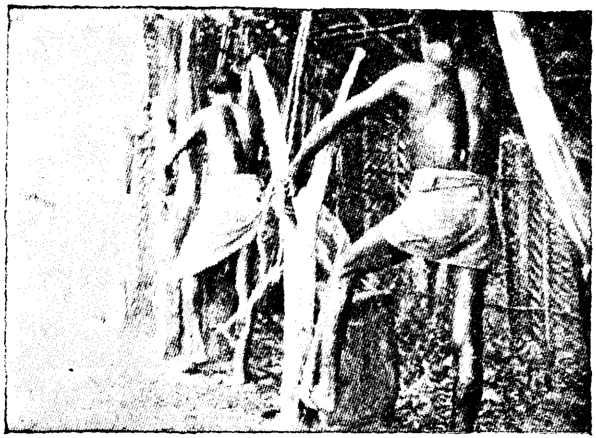


Fig. 1

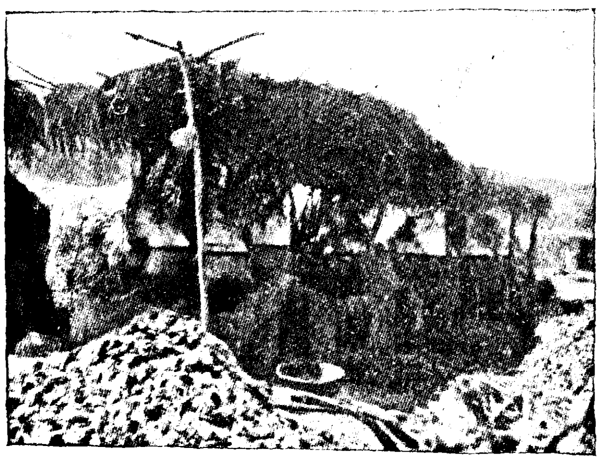


Fig. 2


Fig 3

Katha Manufacture In Bhatkal and Coondapur Ranges.

By M. A. Gokran, (Ranger in the Forest Utilization Office, Bombay Province, Poona).

S|o|Bo., Md., G|92-katha|Bo., Md.—The method of **katha** manufacture in parts of Bombay and Madras is described. Chemical analysis of a sample from Bombay shows that the locally manufactured product compares favourably with the best quality of **katha** in the market.

Introduction:— War-time scarcities gave an impetus to the revival of the **katha** industry owing to increasing demands for dyes and other uses. The following is a brief description of the method of manufacture followed in Bhatkal range of Kanara western division and in Coondapur range of Madras Province.

The **khair (Acacia Catechu)** trees from malki or purchased from the forest department out of minor forests are cut flush with the ground and made into convenient pieces according to the workable bole and even the big sized branches are used for the purpose. The largest and the heaviest piece might be about one maund of 80 lbs. The bark and sapwood is completely removed by axe. Such fashioned pieces are brought to the site of the still from forests, generally as head-loads and occasionally in carts. Chipping the **khair** pieces is done by ingeniously hanging the pice of wood so as to rest it on a chopping block (Fig. 1). It is so hung that even the smallest piece can be held on the chopping block firmly at the angle desired by the chopping coolie. The heartwood is chopped with an axe or by sharp **koitas.** These chips are taken and poured into copper pots of oval shape about 6 gallons capacity kept over an oven made of bricks plastered with earth and cowdung. Each oven is so constructed as to hold 5 copper pots (Fig. 2). The chips are boiled with equal quantity of water in the copper vessels for about 3 to 4 hours when the extract liquor is taken out from all the pots. This extract liquor is passed through cloth to remove all the dust and chips of **khair** logs and the liquor thus obtained is again boiled in a separate copper cauldron until it gets to the consistency of a syrup which is then poured into a wooden 'boat' scooped out of mango logs and allowed to cool for about 8 hours (Fig. 3). During this period, the liquid **katha** begins to dry. The workers adjust their work in a systematic way so that the boiling is done during day time and cooling the liquor during evening and till mid-night. When this liquid cools to a thick paste measured handfuls are taken out and beaten with specially made wooden mallets or spatulas by which process it gets hardened. The **katha** is not cooled in a sandpit at any stage. Insufficiently boiled liquid is returned to the piece-workers. The workers are paid by quantity of syrup of the correct consistency,' the quantity being measured by the 'boat'. Small uniform blocks are made by an expert who uses a wooden mallet and platter. These small blocks weigh about 5 tolas in weight. These can be seen in Fig. 3. The blocks are further dried in the cool shade of a tatched hut fitted with racks.

The fuel used for the manufacture of **katha** is the waste chips, ends of the logs and other firewood.

Drawbacks in the method of manufacture of katha.

Analysis

The old method is slightly modified in the method described above. The crude method of making use of earthen pots for boiling is replaced in this method by copper vessels and the **katha** instead of being cooled in a pit, is made in a clean wooden trough.

A sample of **katha** obtained from Bhatkal range of Kanara Eastern division, was chemically analysed with the following results :—

	Sample	Best quality bazaar katha
1. Moisture.	12.40%	6.45%
2. Ash.	3.170%	3.620%
3. Nontannic Organic matter. (insoluble in ethyl acetate	29.38%	38.150%
4. Matter soluble in ethyl acetate.	50.98%	48.630%
5. Crystaline catechu from above soluable. matter on the original sample.	4.074%	3.152%

This shows that the **katha** compares favourably with the best quality bazaar **katha.**

Rainfall Record.

By K. L. LAHIRI

(Silviculture Branch, F. R. I., Dehra Dun)

G|0453|R.I. G|1114|R.I.—In the usual type of rainfall gauge in India, the want of a standard height at which the apparatus is placed above ground is pointed out. The rainfall at New Forest is discussed vis a vis the need of a knowledge of shower intensity. The records for four months of an automatic rain gauge installed by the Central Silviculturist at New Forest are published, from which, when more data accumulate, the mean and maximum intensities of each shower can be studied.

The influence of rainfall on plant growth has been realised ever since students of plant geography accepted it as an important factor governing the distribution of plants over the world. Though the method of expressing this rainfall changed with the changed needs, the method of measurement, with minor alterations, remained the same till recent years. The rain-gauge, most commonly used in the forests of India, is a "single bottle" type, known as Symon's rain-gauge. In it the rain, collected through a funnel, is stored in a bottle till measured in a measuring glass. The measurement is, generally, taken once a day. The measuring glass is calibrated with the area of the collecting funnel and the reading directly gives the depth, in inches, of rain that would have collected over the area, if nothing was lost by evaporation or percolation.

A knowledge of micro-climate requires a standard height for the rim of the rain-gauge. In British stations it is one foot from the ground, but in India, there is no standard height for the rain-gauges in use in the various forests. Under Indian conditions, one foot is not the ideal height, as during a heavy shower, the rain drops easily bounce that height and thus can interfere with the record.

An expression, equivalent to the 'regime' was probably the first one used in expressing the rainfall of a region. Average yearly rainfall has been, and still is, the general way of expression. Discovery of the differential effects of rainfall during the growing and dormant seasons has demanded and found yet another expression in average monthly rainfall. An expression in the number of rainy days is also significant, particularly in the tropics, where most of the rainfall of a month is concentrated in a few showers. Here it may be noted that KENDREW, W. G. (1938) in his CLIMATE, has defined a rainy day as being one in which at least 0.01 inch of rain is registered whereas the meteorological department in India defines it as when 0.10 inch is registered. Obviously we follow the latter.

The mean annual rainfall in New Forest, calculated from the record of fifteen years from 1931 is 85.98 inches. In figure one, this has been shown against the totals of each year. New Forest lies between 30 dig. 19 and 30 dig. 22' N. latitude, and compared with other places on the same latitudinal position, records a heavier rainfall. This is perhaps due to its physiographical position. We have not yet recorded for a period long enough to comment on the average variability. In figure II, the average rainfall and the average number of rainy days are shown against each month. The rainfall is primarily of a monsoonal type, but the winter months get about 12½ per cent. of the total rainfall. The effect of this amount is further intensified in favour of plant life due to the better distribution in number of rainy days. The following tables give the heaviest and lowest rainfall recorded for each month and the heaviest fall in any one day.

Heaviest rainfall recorded :

Jan.	7.02	April	2.62	July	38.28	Oct.	4.63
Feb.	5.49	May	4.89	Aug.	52.02	Nov.	0.84
Mar.	5.99	June	18.53	Sept.	26.03	Dec.	3.59

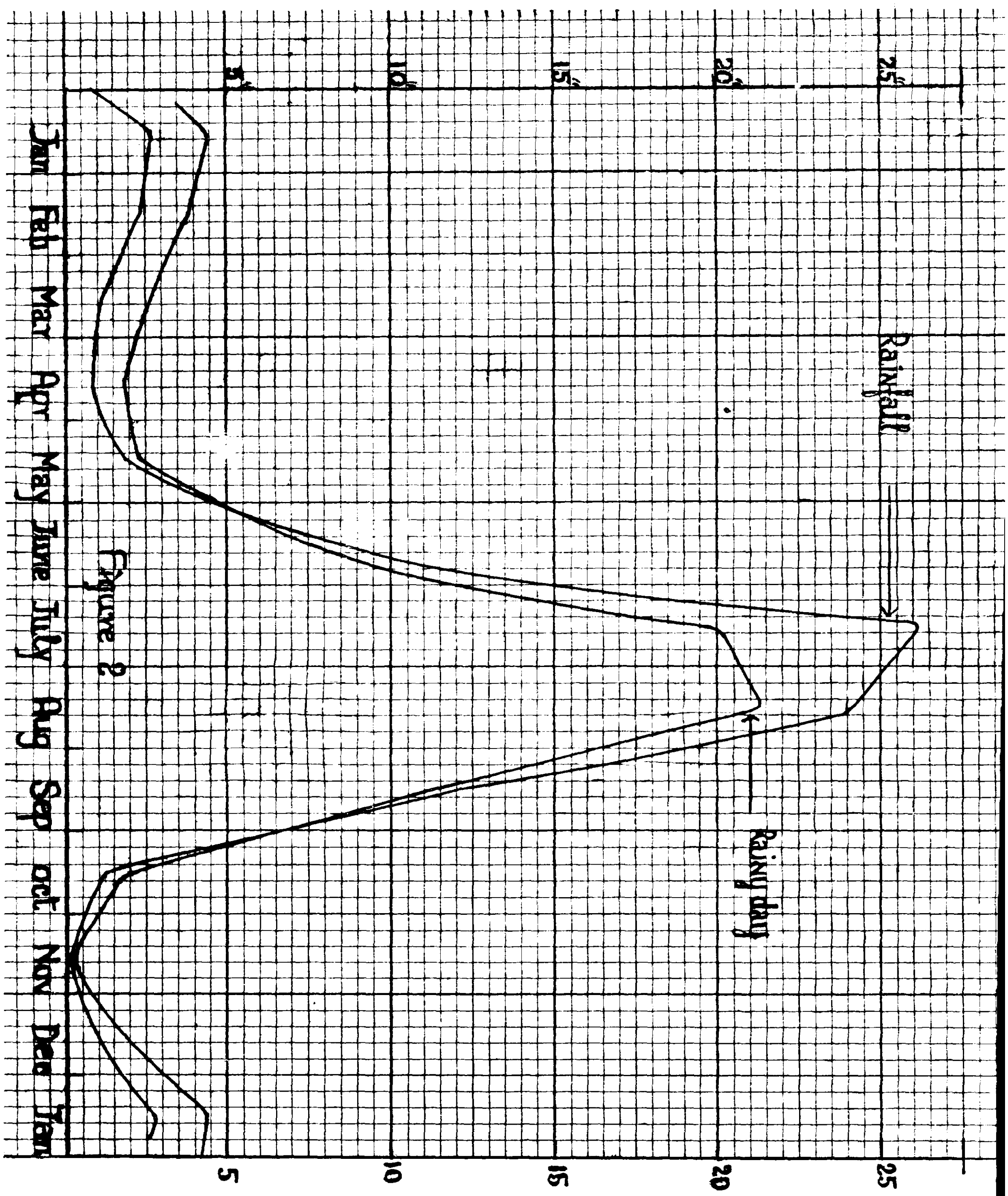
Lowest rainfall recorded :

Jan.	0.03	April	0.06	July	13.43	Oct.	Nil
Feb.	0.45	May	0.03	Aug.	16.01	Nov.	Nil
Mar.	Nil	June	0.99	Sept.	4.51	Dec.	Nil

Heaviest rainfall in one day:

Jan.	3.12	April	1.39	July	8.28	Oct.	2.83
Feb.	3.58	May	3.49	Aug.	8 66	Nov.	0.84
Mar.	1.92	June	5.02	Sept.	7.86	Dec.	1.65

The remark nil against any month does not really give true comparative picture. In our fifteen years' record, March had no rainfall only once ; October, five times; November, nine times; December, four times. November is the driest month and the period from October till December is the driest period, (humidity, soil moisture etc. not being considered). The effect of low rainfall is not much felt in October, it being the first month after the monsoon.



No, of rainy days.

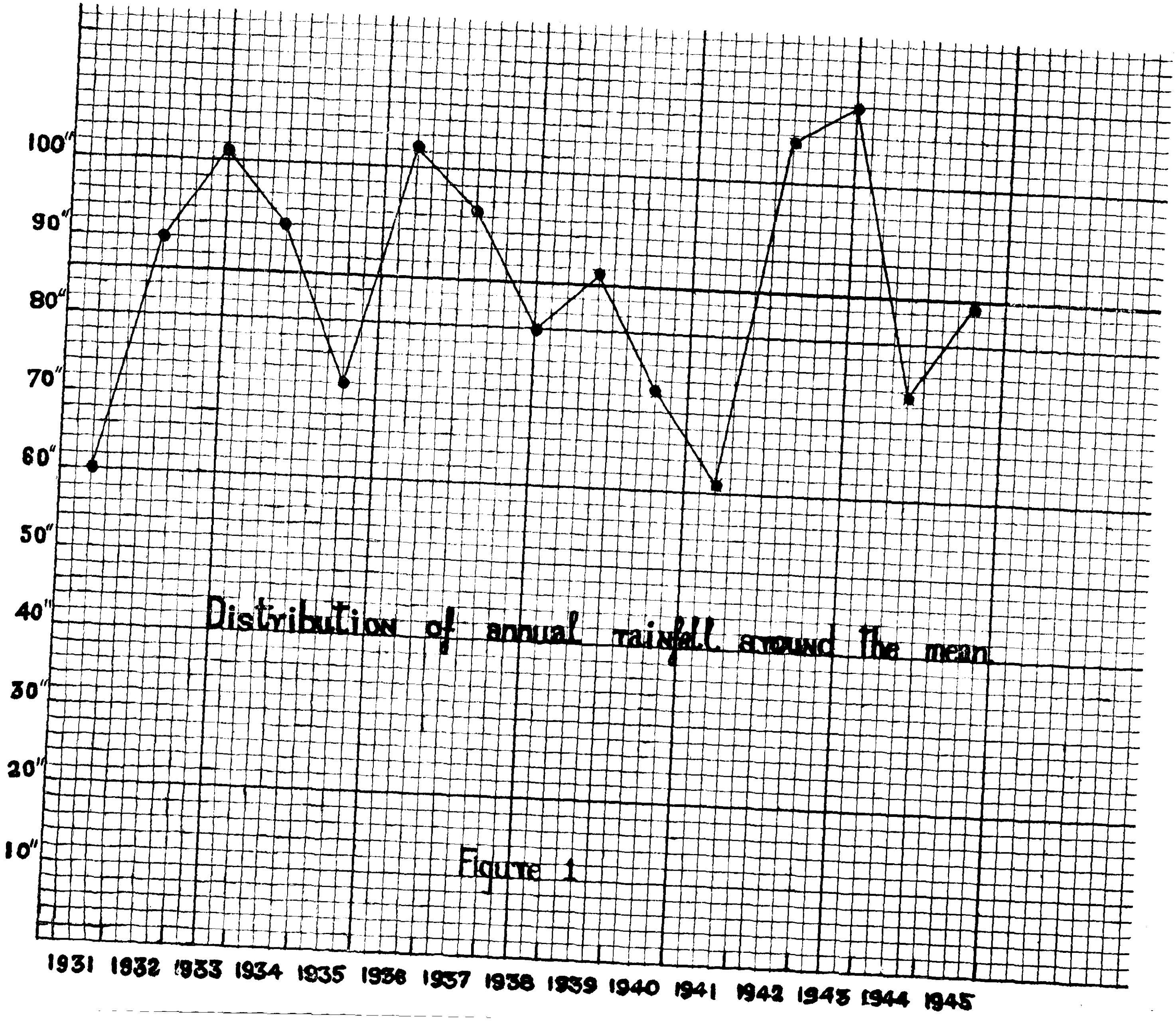

Distribution of annual rainfall around the mean.
100"
90"
80"
70"
60"
50"
40"
30"
20"
10"
1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945

Figure 1

All the above expressions of rainfall are based on data collected by Symon's rain-gauge. Purely for the purpose of growing plants, particularly trees, the above data would seem to be adequate to present a picture of the growth conditions. The position is rapidly changing today ; interactions of factors have been discovered by statisticians and ecologists have also realised them; pedologists demand the expression of rainfall in relation to the capillary movement in any particular soil concerned; soil conservations have realised that neither the monthly average nor the number of rainy days gives him enough detail to guard against erosion. For example, the rainfall in August, 1943 recorded the heaviest fall, with the heaviest one day fall of 5.27 inches and 28 rainy days. But in 1942, with a total fall of 41.02 inches for the month, and 29 rainy days, the heaviest one day fall was 7.02 inches. Again, in one case, the fall might have been concentrated in a few hours, and in the other, spread over 24 hours. Thus a knowledge of shower intensity and duration has become essential for planning soil conservation works and measurement of these factors is not possible with a Symon's rain-gauge.

Recently we have obtained an automatic rain gauge and installed it in our meteorological station. This instrument consists of a tilting bucket which tilts alternately, rotating a dial every time to one cent of rain. As the dial rotates, it moves a pen arm that produces a curve on a paper wrapped round a clock-drum. The drum rotates once a week when a new graph paper has to be fitted. The duration and intensity of each shower can thus be read off the graph. Such instruments, after installation, should be checked as the fine adjustments are liable to be disturbed by careless handling. Though it is not expected that this type will replace the Symon's rain-gauge in the forests, the automatic rain-gauge is essential in divisions where erosion is a problem. We are, here, using both the types, but it has not been possible to set the automatic one to standard British height.

The rainfall record as collected by the automatic rain-gauge from 1st June to 30th September of this year is tabulated and published below. In this, a break of less than one hour has been neglected and showers have been classified by the total fall. From such data collected, it is possible to study the relationship of mean and maximum intensities for each shower class, the time and character of each fall, run off, and other phenomena. Such a study, of course, must be postponed until we have accumulated much more data.

Jarrah - Australia's "Believe It Or Not" Tree.

By Edgar Bee.

Jarrah is one of the finest hardwoods in the world and one of the two undisputed monarchs of the West Australian forests. **Karri,** the other, is the bigger tree, but **jarrah** is the more valuable and versatile timber.

Jarrah—Eucalyptus Marginata if you must go all botanical—is a very unusual and useful hunk of tree. One peculiar thing about it is that it flowers only once every five or six years. An advantage is that the timber, when used for outdoor construction, does not need painting: a coat of oil every year or so preserves it against weathering. Not only does it resist fire, but also damp, white ants, teredo, etc. It can be used in practically every trade.

JARRAH AS FIREWOOD AS WELL AS FIRE-RESISTANT

This rich dark red fissile timber called **jarrah** is a little heavier, on the average, than English oak (Hardness, Grade 2; Weight, 50-64 lbs. per cu. ft. air dry), **will** burn. In fact, waste and reject **jarrah** is sold and used extensively as firewood in the south-western corner of Westralia. It will burn all right if you wait till it dries out thoroughly, chop it up small, then get down on your knees and pray hard. Many Westralians shove the stuff into their stoves and hope for the best, because in many parts of the State there are not adequate supplies of better firewood. Practically all Westralian timbers are hardwoods, and **jarrah** is plenty hard—exceeded only by ebony, and **Lignum-vitae.** It chars to a hard black ash on the outside of the pieces you are trying to cook a meal with, and then goes out as like as not. And it does not give much heat.

Although used as firewood, it is in many a Westralian country home the material from which fireplaces and chimneys are made, built upon a stone base. They are, of course, built large, but they take roaring log fires—and take them year after year without ever burning out.

I asked Dr. M. R. Jacobs, principal of the Australian School of Forestry, Canberra, to tell me in scientific terms just how fire-resistant **jarrah** is. He said he could recall no comparative tests. However, for constructional work, beams of **jarrah** were about the best fire-risk you could get, because they merely char on the outside and.....

For fire-resistance it is one of the best of Australian timbers, most of which excel practically all foreign timbers in this respect. Only Burma teak and English oak show a rather lower comparative resistance than the average Australian hardwood. And more than 90 per cent of the timber trees of Australia are hardwoods of the genus Eucalyptus.

Jarrah is one of the eleven timbers (excluding softwoods impregnated with ammonium phosphate) permitted to be used by the London County Council as fire-resisting material for building purposes. At least one authority says that for beam and column construction it is preferable to unprotected steel; steel will buckle from heat before **jarrah** will burn through and collapse.

Jarrah may be a poor firewood. And while we are knocking it, let us also add that its comparatively low breaking strength brings it into Class 3, and that it is slow-growing: so much so that a fully-matured tree grown from seed will take 100 to 150 years. Some **jarrah** trees are estimated to be 1,100 years old.

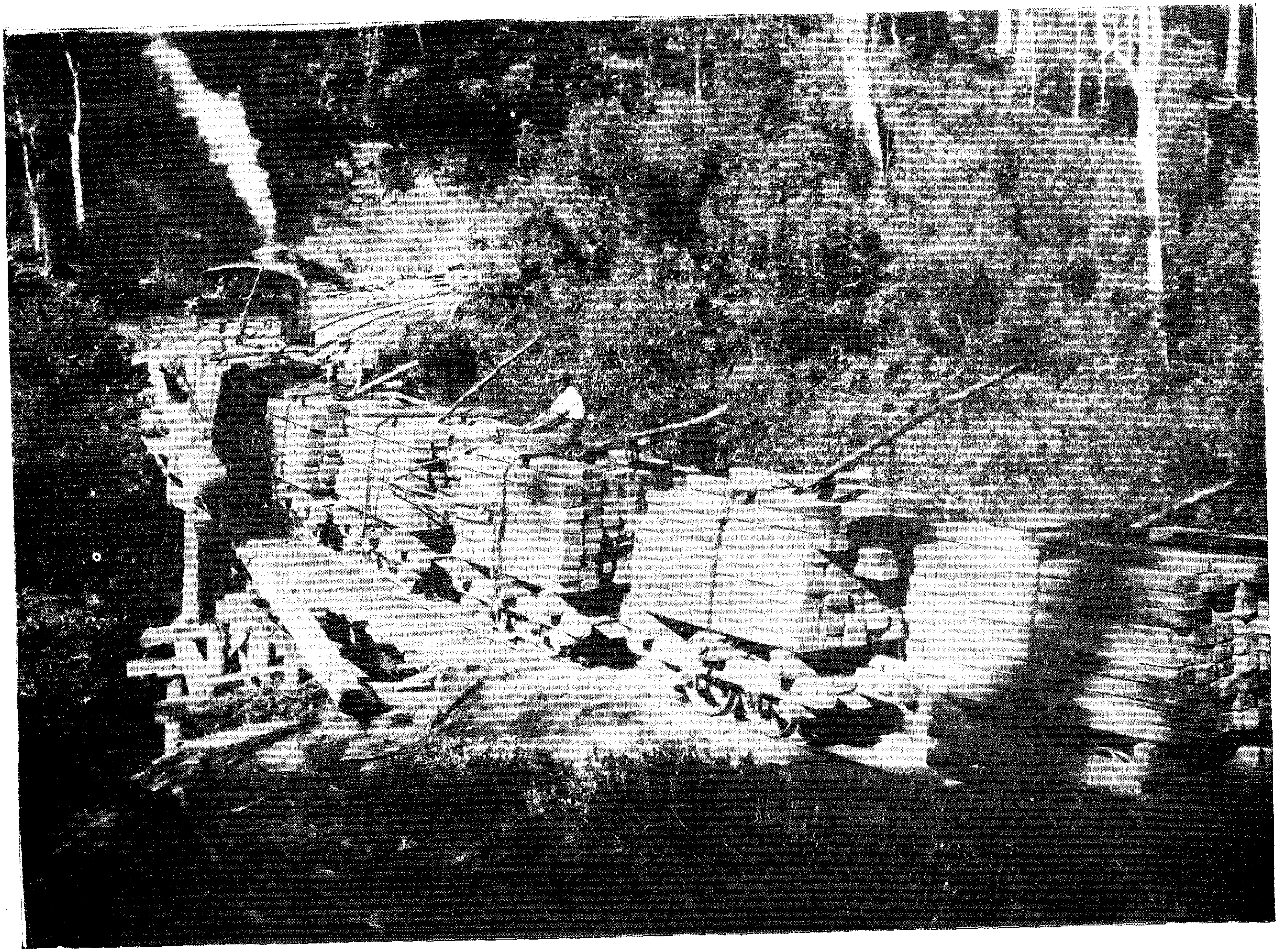
JARRAH'S MULTIFARIOUS USES

In most respects jarrah is tops. You can put it into the ground as sleepers for railroad or streetcar tracks and it will outwear the rails themselves. Its durability in the ground is 40 to 70 years; white ants won't touch it. **Jarrah** sleepers used for a streetcar track in Perth, capital of West Australia, were taken up after 25 years because the rails were worn and rusted past use. Most of the sleepers went right back for further duty. For railway sleepers both **jarrah** and **karri** have gone into service the world over. **Jarrah** is the best: **Karri** must be "powellised" against white ants. This process consists of boiling in a mixture containing molasses and arsenic.

Before the war some 30,000,000 superficial feet of **jarrah** sleepers were exported annually from West Australia to overseas countries. In 1938-39, for example, **jarrah** railroad sleepers both at home and overseas, **jarrah** was from the outset intimately linked with the colonial history and economy of West Australia. Perth's Town Hall was shingled with it for many years. For the machinery, shafting and cog wheels of flour mills it was used in the early days. Likewise, it went into carriages and wagons.

Because of its rich red colour and high polishing qualities pioneers hopefully sent samples to British pianoforte makers, who were highly impressed. They continued to import their timber from the Honduras and Guatemala only because they could get it cheaper there—the long sea-haul from West Australia added too much to cost. **Jarrah,** amongst the best of the Eucalyptus for beauty in grain and colour, is highly valued as a cabinet timber. It mellows with age and polishes up to resemble mahogany —hence furniture-makers give it the euphemism "Swan River Mahogany", naming it for the river on which stands West Australia's capital city, Perth.

It is particularly suitable for office fittings and panels, billiard tables, wainscotting, baluster rails, railroad car decorations, shop fittings. Of its carving qualities one authority writes that its texture is hard rather than tough, and that "it responds to the tool with a crispness which enables the carver, skilled in smart cutting, to produce a brilliant effect and vivacious modelling... It cuts 'as fresh as a carrot.'" He adds the warning that it is inclined to be brittle.



—Mill train hauling Jarrah

Although the grain is interlocked, in most **jarrah** trees, it is fairly straight. However, for beauty of figuring a piece of polished curly **jarrah is** unsurpassed. To get a good surface on this stuff you need to keep your plane razor-sharp and set very fine. You also need to keep your temper thoroughly in check. Curly **jarrah** is even more durable than the straight-grained sort; it is slower-growing, and is found in the sparse marginal areas on the fringes of the prime forests.

"GIANT"—LAND

It is easy to see, then, why **jarrah** was the earliest export from Western Australia. By the end of last century an enormous overseas demand had been created for the timber of these trees with the deep-fissured dark-grey, brownish or nearly black bark which grow, with a reddish tinge, often in company with **karri,** red gum and worth a total of Rs. 26,40,000 went to the United Kingdom, Ceylon, Mauritius, Nauru, New Zealand, the Union of South Africa, Portuguese East Africa, Egypt, Iran, Iraq, as well as to the various States of the Commonwealth of Australia.

One of Perth's old colonial buildings was on **jarrah** posts driven into the ground. When taken up after 70 years they were perfectly sound. Another Perth building demolished after 84 years' service had jarrah roof, wall-plates and joists as sound as the day the place was built.

Jarrah's imperviousness to damp and that wily mollusc the Teredo borer makes it ideal for marine construction—particularly jetty piles. However, to be quite sure against Teredo, Limnoria, Chelura, etcetera, preservative treatment is advisable. Piles taken from bridges 50 years in position in West Australia have been sound.

By the same token **jarrah** is good for shipbuilding and is listed at Lloyd's of London as an approved timber. It is particularly recommended for ships' planks. **Jarrah** helped make Westralian maritime history. Before the days of steam, many a stout vessel built on the banks of West Australia's few rivers, and registered at the port of Fremantle, (Western Australia), sailed the world and founded local fortunes. **Jarrah** luggers still operate off the famed and cosmopolitan pearling port of Broome in the north-west of the continent.

Jarrah is very widely used for road paving blocks. **Jarrah** and **karri** have paved the streets of many famous cities. Charing Cross, London, was paved with **jarrah** blocks as early as 1890. Other famous thoroughfares so paved include the Rue Lafayette and Rue Chateu d'Eau, Paris. St. Kilda Road, Melbourne, is paved with **jarrah** blocks. **Both jarrah** and **karri** have done similar duty in South Africa, South America and many other parts of the world. The Pall Mall, Piccadilly and Regent street were paved with **karri** blocks. **Karri** has the quality of not being slippery. The floors of the Art Gallery and Museum in Melbourne were laid with **karri.**

Jarrah is widely used for telegraph poles, mine cage guides and shafting timber, bridge decking, many aspects of building constructional work, including beams, joists, plates, flooring, rafters, window frames, weatherboards, posts, rails, scantlings.

Because it was plentiful and its versatility was soon appreciated some Acacias, in a belt of coastal country between 50 and 100 miles wide extending from Albany in the extreme south of West Australia for about 400 miles northwards.

The average **jarrah** is between 90 and 120 feet high, yielding between 40 feet and 60 feet of clean log length, while "King Jarrah" at Manjimup (Western Australia) is 145 feet high, and has 26 feet girth 4 feet from the ground. The bole measures 95 feet and the tree is estimated to contain 22,800 super feet of marketable timber. There are said to be bigger **jarrahs** in the forests further north. The yields from the virgin forest is between 5,000 and 6,000 cubic feet of **jarrah** per acre.

The giant of the Westralian forests is the **karri.** One of these, the "King Karri" near Karridale is on record as having a total height of 342 feet, with a bole length of 242 feet and a girth of 40 feet. Another 265 feet from ground to top of foliage, with a bole measurement of 135 feet and a girth 33 feet 4-1|2 feet from the ground and 19-1|4 feet 113 feet above ground, yielded 62,200 super feet of sound timber weighing 120 tons. There was one hollow **karri** tree near Denmark, W.A., through which a bullock team could be driven with ease. **Karri** trees have yielded jetty piles up to 90 feet in length.

In the green depth of these forests work those short heavy men known colloquially as "jarrah-jerkers", their tools are axes and steel wedges, cross-cut saws, tractors and whims—pairs of giant wheels under which logs are slung for towing from forest landing to mill. Theirs is a hard muscle-building life and a skilled occupation. Years of experience have gone to the acquirement of that knowledge of trees and timber-working which enables them to fell a "stick" so that it falls to within an inch or two of any selected spot.

They can cut down a 4-ft. diameter hardwood in 50 minutes. When it comes crushing down the warning cry "tim—ber!" rings through the forest.

There are more than 3,600,000 acres of dedicated State forests in West Australia, and in a normal year some 38 million cubic feet of log timber, about three-fifths of it **jarrah,** is cut from them—timber worth more than Rs. 16,062,500 in all. Pure **karri** forests, incidentally, cover only about 150,000 acres.

HUGE EXPORTS

In 1836, West Australia exported 120,000 super feet of timber worth Rs. 33,250. From such small beginnings the industry grew. Timber exports in 1860 were worth Rs. 65,750; in 1938, Rs. 10,709,000 in 1939, Rs. 77,10,000. In 1938-39 undressed timber to the value of Rs. 50,30,000 went to the United Kingdom, British West Africa, Ceylon, Cyprus, British Malaya, Mauritius, New Zealand, Union of South Africa, Portuguese East Africa, Belgium, Egypt, Germany, Iran, Iraq, the Netherlands, U.S.A., and the States of the Commonwealth of Australia. This from a State with a population of 493,000 and employing about 4,200 persons in forestry shows the importance of **jarrah** in the State economy.

In the boom years of the industry, 1925-28, average production was 237 million super feet a year. In the immediate pre-war years this had fallen, largely because of indiscriminate cutting in the past, and the need for replanting and conservation, to 160 million super feet annually. In 1944-45, under the war-time quota, production was 105 super feet. However, the trend is now upwards. Some new mills have been or are being built. Production in 1945-46 was about 110 million super feet.

During the war years a quota system was imposed on the industry. The production quota is now 115 million super feet a year, of which only 12 per cent can be expected beyond Australia, which permits only token exports compared with some 56 million super feet a year pre-war. Such exports are for essential purposes only—mostly railroad telephone and shipbuilding.

The way in which export volume has been affected by the quota system is shown by the fact that exports from the State in 1944-45 were 34,200,000 super feet, of which only 5,500,000 super feet went overseas, while exports to other States of the Commonwealth were nearly 50 per cent higher than in 1938-39, when total exports to all points were 68,600,000 super feet.

This position is due to rehabilitation needs within the Commonwealth caused by the war. Normal times will come again, and **jarrah** will be available for the world's needs. The hardwood forests of West Australia are the most important timber reserves in the Commonwealth. West Australia and Tasmania are the only two States of the Commonwealth with a timber surplus.

Although the boom in the milling of **jarrah** has passed, the supply will continue so long as the demand lasts, thanks to Westralia's enlightened policy of forest regeneration and care the most advanced in Australia. Foresters now zealously guard immature stands of **jarrah** and stringently supervise the milling of mature trees. C. Hartley Grattan, Carnegie Fellow and author of **Introducing Australia,** visited the important milling centre of Pemberton in 1938, and studied Westralian forestry. He has since pointed that the policy of timber conservation as practised in Western Australia is in many respects ahead of many other countries.

My Combat With Ghost.

By S. P. SAHI, P.F.S.

It was during the early days of the World War II, that I experienced something about the truth of the evil spirits. I say truth because it could not have been anything otherwise. I had just then passed out of an Officers Training School and had received my first posting orders in an infantry batallion at Delhi Cantonment.

Housing problem in those days was just as bad or perhaps worse than during the latter days of the war. The Officers Mess was full up and the hutted accommodations for officers were then under construction.

So my C.O. allotted to me a single accommodation in a bungalow occupied by a young married

officer of the unit. This bungalow was a peacetime dwelling of the **burra-sahibs** and contained ample space and luxury fittings, with spacious lawns and gardens and hedges, trimly maintained.

At the time of my arrival in the station in August, my neighbour's family had gone to the hills. So I was lucky in getting for myself a nice suit rooms. The room which I decided to make into my bed-room was particularly attractive. It contained no less than four large glazed windows and plenty of ventilation.

That first night there happened to be a gala night in the Mess. I had taken liberally of liquid refreshments from the C.O. and the Second-in-command, followed by a late **buffet.** So when I returned to my bungalow it was past 11-30 p.m.

My bearer, whom I had brought with me from the O.T.S. drowsily kept on waiting for me. I let him go with a **sabash** after ordering for the **chota-hazri** at 6-30 next morning.

I went to bed, after securing the doors from the inside but leaving the windows open. It was safe enough that way since the windows were provided with fine meshed wire gauze. I felt cosy in my bed, the ceiling fan over me was in full blast and the neat furniture and curtains looked so alluringly fascinating. I pressed the bed-switch of the table-lamp and it was dark. I was feeling somewhat tired and soon fell in a reverie. My thoughts went back to the Mess. I could see the hazy faces of all the guests—the through the darkness, black streaks of clouds gaily lit premises, the **abdar** busy at the bar-counter. The music of the "Wish me luck.... " resounded into my ears. I thought of the C.O., offering me a drink and cracking a small army joke. Soon I was in deep slumber.

* * *

Tuck ! Tuck ! ! Tuck ! ! !—a stealthy noise came to my sub-conscious mind. I was fast asleep. The noise became more frequent until it multiplied and filled the room. Half awake, I thought of the Big-ben beating with a rhythm. Surely it could not have been the clock. Was anyone walking tiptoe inside the room or practising a slow-motion tap-dance? By now I was full awake. I tried to look around through the darkness, but I could see nothing except the radium-dial of the Big-ben on the mantel-piece. I could see only one hand of the clock at 2. Where was the other? God bless me! it was 10 minutes past 2.

The confusion had meanwhile increased multifold. It looked to me as though there were a thousand people engaged on tap-dancing. My heart was beating rapidly—the drone of the ceiling fan had drowned in the din.

I mustered courage, and tried to gather my nerves. I succeeded partly. I stretched forward my hand to find the bed-switch of the lamp. It was nowhere to be found. Then I thought of the "safety first." My hand promptly went underneath the pillow to grab the big hunting knife which I always kept with me by night. I touched its knurled handle but before I could get hold of it, it slipped down. Oh, hell, I must get up to pick it!

I tried to get up—to stand on my feet. But something was holding me back. I turned on to my elbow and convulsively struggled. But in vain. My eyes were wide open. I could see the Big-ben on the mantel-piece—it was now 15 minutes past two. What looked to my perplexity a spell of several long hours had, in fact, been only a trifling duration of 5 minutes.

I was in perfect senses.

Then something-else happened. I saw descending from the ceiling. The sickening noise of the thousand and one "Tut" "Tuts" suddenly declined until it completely fizzled out. But its place was instantly taken over by the surreptitiously approaching black fog which was descending over me like a multi-limbed giant octopus. It came right over me until I could see no more.

I was groaning under the exceedingly heavy weight of some one or something. My lungs were being constricted. My whole body had frozen. I was sweating heavily—cold and crystal sweat! I knew somebody was murdering me in cold blood—somebody whom I could not see, whom I could not understand—whom I could not feel with my touch, but nevertheless whose great capacity of crushing to death I fully felt. I screamed vociferously—which could be heard from miles—I shouted at the top of my voice for my servant, in fact I made all sorts of phonetic efforts. My fear and surprise knew no bounds when I discovered that no response whatsoever was forthcoming from any quarter.

So, at last I decided to die the painful death as best as I could. There was no alternative left. The monster had not relaxed its hold upon me. My breath was failing fast. Suddenly it tapered off and I felt the last pain on my mortal remains. I lay dead—completely dead.

I do not know when and how life came back to me. It has remained a mystery to me until to-day. Was I not quite dead then? Had I merely fainted? I cannot commit one way or the other.

The first signs of life came back to me with 6 O'clock. There was someone outside saying something in loud but supressed tones. It was so vague, so indistinct and to me it looked so inarticulate. That speech from outside persisted. After tremendous mental conflict and effort my mind woke as though from deep drunken slumber. I caught one word that the fellow from outside was uttering and I clung to it body and soul. "Chaw-chaw" It was my bearer shouting "Cha-Hazuh!"

The whole day I carried the fatigue of the long-drawn struggle of the previous night. I could hardly concentrate on my work or partake of the light gossips and funs in the Mess. I felt so sick and depressed. My mind was heavily permeated with the ghastly reminiscences. "Was the room haunted?", "Do ghosts really exist?" These were some of the questions I was asking to myself.

I was wise enough not to tell of my horrible tale of woe to anyone else. I knew the ways of the army, people would begin to scoff soon and turn it into a big joke!

Two months later my neighbour's wife and children and the Aya and the dogs returned from the hills.

* * *

My neighbour gave a cock-tail party in honour of their return. All the battalion officers and the wives of married officers attended.

Later, I was talking to my hostess. A very charming lady she was indeed. I somehow manoeuvred the talks and deftly brought the topic on to my suite of rooms. "O, you see" she said "the big room over there is frightful. We seldom dared to walk into it alone even in daylight. It was all sorts of forms and figures in it. I hope you understand what I mean. I am not quite sure, but the old mali says there lies an ancient grave buried beneath the floor. I'm sure you are not using that room for your bed-room—though obviously it seems an ideal one for that?"

"No", I instantly replied "my bed-room is in the next one."

And truly too, I had not dared to sleep into that room after my combat of the first night!

Convocation of the Indian Forest College and the Indian Forest Ranger College, Dehra Dun, 1948.

The joint convocation of the Indian Forest College and the Indian Forest Ranger College, Dehra Dun, for the passing out of the 1946-48 classes took place before a very large gathering in the sports pavillion of the Indian Forest College at 4 P.M. on Tuesday the 30th March, 1948. (The convocation was originally arranged to take place in the Convocation Hall on the 31st March, forenoon, but to suit the convenience of the Hon'ble Minister Mr. Jairamdas Daulatram, the revised venue and time were adopted).

The Hon'ble Minister Mr. Jairamdas Daulatram, Minister for Food and Agriculture in the Government of India presided over the convocation and presented the diplomas, certificates and prizes to the outgoing classes. Along with him on the dias were Mr. A. P. F. Hamilton, C.I.E., O.B.E., M.C., I.F.S., Inspector General of forests, Government of India, Mr. C. R. Ranganathan, I. F. S., President, Forest Research Institute and Colleges, Mr. C. A. R. Bhadran, M.B.E., I.F.S., Director of Forest Education, Rai Sahib V. P. Mathur, Principal, Indian Forest College, and Rai Sahib B. S. Chengapa, Director, Indian Forest Ranger College. The sports pavilion and its neighbourhood were tastefully decorated for the occasion.

In spite of the short notice of change in the time for the convocation a very large and distinguished gathering including visitors from the Indian Military Academy, the Cantonment and the town of Dehra Dun was present to grace the occasion. The officers and staff of the Forest Research Institute and Colleges as also their families were present to add to the impressiveness of the occasion. The outgoing classes com-

prised of 75 students, 21 from the Indian Forest College and the rest from the Indian Forest Ranger College. There were also present students of the 1947-49 classes of these Colleges and the new arrivals for the 1948-50 classes.

The convocation commenced at 4-15 p.m. The President, Forest Institute and Colleges, opened the proceedings with a short address of welcome to the Hon'ble Minister Mr. Jairamdas Daulatram and the visitors in the following words:—

"It is with great pleasure that I welcome the Hon'ble Sri Jairamdas Daulatram to our midst to-day. We consider the convocation of the Forest Colleges as a very important event in the calendar of the Forest Research Institute and Colleges, and we are therefore deeply sensible of the honour that the Minister for Food and Agriculture has done us in consenting to preside over the occasion, despite the many calls on his valuable time.

Many events of outstanding significance have happened in our country since the last convocation. It is not usual to refer to political events on an occasion like this, but the events to which I take leave to refer are of such stupendous importance and have so altered the spirit, outlook and atmosphere of this Institution that I make no apology for mentioning them. It would indeed be surprising if I failed to do so.

The saddest event of the eventful twelve months since the last convocation is the passing away of Mahatma Gandhi. It is not for me to speak of his role in human history, the part he played in the Indian scene or the place he held in human hearts the world over. These things have been said better than I could hope to say them by innumerable men and women from all countries. These spontaneous tributes, such as have never been poured out in such abundant and overflowing measure for any king or conqueror, priest or prelate, have both uplifted and shamed us and induced in us a strange mood of humility and pride, humility in that we proved ourselves in the last analysis unworthy of the greatest Indian since Buddha, and pride in that the soil and climate of India can still, as of old, produce a spiritual master of men. It is good that we should grieve over his death for such grief chastens and refines. I would, therefore, ask leave of the Chairman, himself a lifelong associate and lieutenant of the Mahatma, to propose that this convocation should pay its tribute to the departed father of the nation by standing and observing silence for two minutes.

On the 15th of August, 1947, we re-entered the company of free and independent nations after a long dark period of suppression and tutelage. In this Institution, as no doubt elsewhere, we felt we had come of age and our joy at the advent of freedom was tempered by the weight of responsibility that had descended on our shoulders. As we took the oath of allegiance to the new Indian dominion, we resolved, each one of us, to uphold and enhance the high prestige and position which the Forest Research Institute and Colleges already enjoyed in international circles and to make it an active instrument in the plans of social and economic regeneration which the new Government had in view.

Our plans suffered a set-back on account of the unfortunate civil disturbances, the migration of populations and the breakdown in communications which occured in September and October. But we take pride in the fact that even during the worst days of this dark interlude of mob violence and hysteria, we effectively protected the residents of the estate of all communities by organising day and night patrols. I should like to take this opportunity of acknowledging our debt of gratitude to the Commandant, staff and cadets of the Indian Military Academy for the armed patrol they supplied every night for several weeks for the protection of the residents of New Forest and for the valuable work they did in restoring morale through their well written daily bulletins.

The Forest Research Institute and colleges was declared a unique institution and and it was intended that Pakistan should continue to make use of it both for research and for education of its gazetted forest officers. Pakistan intended from the beginning to make local arrangements for training its rangers. But as a result of the disturbances and the sense of insecurity they produced, Pakistan decided to withdraw all its students, both in the officer classes and the ranger classes. In fact in most cases these students never rejoined their classes after the vacation in September. The abstention of Pakistan students necessitated a regrouping of the junior ranger classes. The original three sections of the junior ranger were reformed into two sections, while the senior classes in the Indian Forest Ranger College and all classes in the Indian Forest College although somewhat depleted continued without change.

The demand for seats at the Forest Colleges has shown a steady increase since 1945. In that year the Government of Madras reopened the Madras Forest College at Coimbatore, as their own immediate requirements of trained rangers were so large that they could not be met by Dehra Dun. In 1947 certain other provinces also made use of the Madras Forest College for training ranger students over and those who could be accommodated at Dehra Dun. Inspite of this

the pressure on Dehra Dun has continued to increase. The reasons for this increased requirement of trained forest staff are various. But the main reason lies in the plans of post-war expansion of provincial forest departments, due to a growing realisation of the great importance of planned forestry in our national economy. There is a growing awareness among our legislators that forestry is not merely a matter of growing trees and felling them for firewood and timber in Government lands that cannot be utilised for agriculture. It is increasingly realized that forestry should be practised on a planned basis over the entire country, that forests should be created if necessary where they do not exist at present, that private forests are national assests to be protected and exploited in exactly the same way as Government forests, and that forestry has an important role to play in preventing erosion, in reclaiming eroded lands, in protecting agricultural lands from sand drifts and water borne deposits of sterile soil, in flood control and conservation of catchment areas, in short that forestry is our cheapest and most effective means of defending the soil against accelerated erosion, of controlling the spread of desert conditions and of moderating climatic excesses.

Even from the point of view of the production of timber, firewood and other forest produce, which may be regarded as the routine function of the forest departments, the need for intensive working and fuller utilisation of our resources has been forcibly brought to light by the prevailing shortages and high prices of all forest commodities. These problems have been investigated carefully by the Central Advisory Board on Forest Utilisation which met here earlier in the month. The solution of these problems has an important bearing on forest education in as much as improvements in intensity of working and utilisation will involve strengthening of trained forest personnel and better forest education.

I should like to refer to the probable consequences, so far as forest education is concerned, of the processes of merger with provinces and of integration into large unions of Indian states that are now going on in the country. In many cases these states are rich in forests which have hitherto not been scientifically managed. To quote two examples, the forest areas of the Central Provinces and Orissa have been very considerably increased as a result of the merger of states. New Forest divisions and circles have had to be created for which trained staff is urgently required. The demand for seats on this account is so great that we may have to form three new classes in the gazetted officers' course and to increase the strength of the new ranger classes to the maximum consistent with efficiency, even if it involves inconveniences in accommodation and touring arrangements.

For many important reasons, into which I will not go here, the Central Government has accepted full responsibilities for the training of professional forest personnel, consisting of forest officers and rangers for the whole of India. As a first step in implementing this policy, the Government of India have decided to take over the administration of the Madras Forest College and to enlarge and reequip it so that it will be able to train two ranger classes and one officer class each year. In order to ensure that the training given at Coimbatore is in no way inferior to that given at Dehra Dun, it is intended to instal research sections in forest entomology, forest pathology and soil science, so that courses in these subjects can be carried out by specialists. It is proposed that Coimbatore should train rangers and officers for provinces and states in the peninsular region, while Dehra Dun would train men for the northern region. The courses at both Dehra Dun and Coimbatore would be coordinated and controlled by the President of the Forest Research Institute and colleges. It is believed that this rationalisation of forest training, conforming to the principal regions of India, would lead to increased efficiency and fruitful results. Moreover, it would serve to relieve the intense pressure on Dehra Dun, where the increase in the number of forestry classes has reached a point where further expansion can only be accomplished at the expense of the high standard of training for which Dehra Dun has been famous for over half a century. There are indications that the annual recruitment of trained forest staff will not diminish for ten years or so. It is also possible that students from far eastern countries and from the middle east may come to Dehra Dun for forestry training.

In pursuance of a recommendation of the Gwyer Committee which investigated the question of forest education, in 1946, preliminary steps have now been taken to affiliate the forestry courses here to Delhi University. A joint Faculty of Agriculture and Forestry has been formed and will soon be expanded so as to admit of adequate representation of interests on the forestry side. The course at the Indian Forest College will lead to a B.Sc., degree in forestry, while that at the Indian Forest Ranger College will lead to a Diploma in forestry. Both courses will for the present continue to be of two years' duration, but the course at the Indian Forest College will be extended to three years as soon as circumstances permit. The first year annual examinations of the 1947-49 courses in both the colleges will be recognised by Delhi University as count-

ing for the degree or diploma, as the case may be. We hope to affiliate the courses in the Madras Forest College to the Madras University in due course.

One of the main difficulties that we are facing both on the education side and the research side, is the slow progress that has been made in the approved building programme. The construction of additional wings to the Indian Forest Ranger College has been halted half way through for many months. The construction of permanent hostel for ranger students has not been started. The same remark applies to the main building and hostels of the Indian Forest College. The lack of residential accomodation for staff is holding up our reorganisation plans. A special construction division of the C.P.W.D. has been in existence for carrying out our building programme, but I regret to say that in spite of the efforts of this division, progress during the year that is now closing has been negligible. I do hope I will be able to tell a different story at the next convocation.

There have been changes of staff during the year. Mr. Mobbs who served as Director of Forest Education from 1945, and had earlier served as Principal of the Indian Forest College for seven years, left the Forest Research Institute and Colleges in July, 1947, to take up the Professorship of Forestry in the University of Bangor. I wish to acknowledge greatefully Mr. Mobb's distinguished services to the cause of forest education in India. Mr. Stewart vacated the post of President of the Forest Research Institute and Colleges in November, 1947, after two years of devoted service to the Institution during a phase of expansion of activities on both the research and educational sides. Mr. S. A. A. Anvery, who had been director of the Indian Forest Ranger College for two years left in June, 1947, on leave before proceeding to Pakistan. His place was taken by Mr. B. S. Chengapa, but I fear that he will shortly be leaving us as his services are urgently required for an important job in the Andamans. M. C. A. R. Bhadran, who had been Principal of the Indian Forest College relinquished that post to take up the post of Publicity and Liaison Officer in the Institute. He has since been appointed to hold additional charge of the post of Director of Forest Education. Mr. D. L. Sah took up the Principalship of the Indian Forest College, but he had to revert to his province where he was required for officiating as a Conservator, Mr. Y. M. L. Sharma, Instructor, Indian Forest Ranger College, and Mr. Brito Muthunayagam. Assistant Lecturer, Indian Forest College, will shortly be reverting to their respective states of Mysore and Tranvancore on the expiry of their period of deputation. I wish to express my thanks to the officers who will be leaving us soon for their services to the colleges and to wish them the best of luck in their future careers.

Before calling on the Director of Forest Education to read his report, I wish to congratulate all the students who are passing out to-day to take up posts in the forest services of India. I wish them all success and happiness in their future careers.

Mr. C. A. R. Bhadran then presented a report on the working of the 1946-48 course of instruction in both the colleges as also on the general working of the colleges in the year 1947-48, as follows:—

Honourable Sir, Ladies and Gentlemen:—

INTRODUCTORY

First of all permit me, Sir, to voice the genuine feelings of gratitude to you that fill the hearts of the students and the staff of the Colleges, for honouring us with your presence here today, in spite of the many other and urgent calls on your precious time in these difficult days for the country.

I feel it a rare privilege that the opportunity has come my way to present this report on the working of the Forest Colleges at their **first** Convocation in free India. Forestry has a full part to play in Land Management or the planned use of all land, besides fulfilling its role as the source for a variety of raw materials for commercial and domestic needs. The former aspect has received comparatively little attention at the hands of foresters up-to-date, although it is now recognised to be of vital importance to full-pledged rural economy in this predominantly agricultural country of ours. Under your guidance, Sir, Forestry, I fervently hope will come to play its full role in the progress of the country; and I am confident the young officers and trained men who will listen to your words of wisdom today will go forth to the various Forest Services in the country, imbued with a full sense of responsibility and service to the people and the country.

The 1946-48 Courses.—In all 75 students have today completed their 2-year course of training. This might be considered a small number to meet the needs of expansion in forestry activities. Actually, the courses commenced in April, 1946, with 107 students, drawn from all parts of Undivided India, and the strength remained at that level to the end of August, 1947. But owing to partition of the country and the unfortunate communal disturbances that followed it a number

of students stayed away from the Colleges after their annual vacation in September, 1947. The Government of Pakistan then decided to withdraw students from their areas and set up its own training arrangements for them. Some Muslim students from areas in the Indian dominion also stayed away from the Colleges.

Of the 75 outgoing students, 21 belong to 1946-48 class of the Indian Forest College and will now proceed to start on their careers as trained Forest Officers. All of them have been through the full two years course, except one who joined for the 2nd year only having previously been through the full Rangers course. Of these 3 come from each of the provinces C.P., Bombay and Madras, 2 each from Orissa and Bihar, and one each from West Bengal, U.P., Gwalior, Junagadh, Kashmir, Rewa, Sirmur and Nepal. The other 54 were trained in two parallel classes of the Indian Forest Ranger College and will now go out to strengthen the cadres of Forest Rangers, often rightly referred to as the back bone of India's forestry organisation. Of these, 7 belong to Bombay, 5 to U.P., 4 each to Bengal and Bihar, 3 each to C.P., and Kashmir, 2 each to East Punjab, Coorg, Sind, Hyderabad and Afghanistan, and one each to Ajmer, Assam, the N.W.-F.P., Orissa, Ajaigarh, Baroda, Bastar, Bharatpur, Datia, Gwalior, Jaipur, Jubbal, Kolhapur, Kutch, Mayurbhanj, Mewar, Rewa and Rairakhol. The few students included here from Western Pakistan areas are non-Muslims who have no wish to go back to their provinces and whom we will have to endeavour to absorb elsewhere.

COURSES OF STUDY FOLLOWED

The courses of study in both Colleges were along established lines, with improvements by way of new emphasis on Soil Erosion and its control, planned land use, village plantations, roadside avenues etc. While almost the same subjects are taught in both courses, the emphasis in the training in the Officers College is on planning, direction and control of work and in the Rangers College on execution of work, but the necessity to learn to execute a job before knowing how to direct it is fully recognised. The course includes the forestry subjects—General principles of Silviculture, Silvicultural Systems, Silviculture of Indian trees, Forest Mensuration, Forest Management, Utilisation of timber and other forest produce, Forest Law, and the related sciences of Botany and Ecology, Entomology, Mycology and Forest Pathology, Soil Science and Geology. A full course of instruction is also given in Field Surveying and Forest Engineering. In the Officers' course, the students are fully trained besides in Forest Management and the preparation of working plans, and forest valuation and policy.

As in the past, the Forest Colleges had the benefit of instruction from various officers of the Forest Research Institute, each in his own special subject. This, we recognise, is one of the rare advantages of the Colleges being an integral part of the Forest Research Institute and Colleges and we are truly grateful to the officers concerned for their help. The constant expansion in classes has resulted in increased demands on their time in spite of the efforts on our part to make the Rangers College at least self-sufficient in its lecture-room and laboratory work.

Particularly in the Rangers College the normal class room programme was considerably disturbed because of the unfortunate disturbances in September, 1947. Students who had gone home early that month for their annual vacation could not return for the start of the lectures early in October. Actually on the re-opening date there were present only 8 students (out of 182) in the Rangers College and it was more than a month before anything like the full complement was achieved. The full schedule of lectures was however completed thanks to the Instructors cooperating to work on all holidays subsequently.

PRACTICAL WORK

As in the past, the classes spent quite half the period of training in practical field work and educational tours. In spite of the many difficulties regarding rationing, transport, etc., the normal schedule of field work and tours was adhered to. Practical field work included lessons in nursery and plantation work, in thinnings cleanings and tendings, markings and fellings in different types of forests, field surveying, road alignment, construction of bridges, and a number of other items which a fully trained forester should know. The officer students prepared, besides, a full scale working plan.

All the students had the benefit of a three weeks intensive course in practical field Engineering at Roorkee with the King George V's Own Bengal Sappers and Miners. The usefulness of this course of instruction is fully recognised and I take this opportunity to express our gratitude to the Commandant and his staff for kindly undertaking this work for us.

TOURS

The officer students toured extensively in various forest areas in all parts of the country in the hills and the plains; and thus had opportunities of studying all types of forests and their working. Every opportunity was also availed of to study experimental and statistical research work in progress in these forests. The tours also included visits to saw-mills, depots, and factories and commercial undertakings utilising forest produce. Emphasis was laid on the assessment of conditions affecting treatment of different forest types, the problems that arise in prescribing treatment and the methods of dealing with them.

The Ranger students toured on a less extensive scale but had full opportunities to study a variety of forest types and their working. They studied in detail the methods of execution of various forest operations and the application of the different treatments prescribed. They also had facilities to visit saw-mills, industrial and commercial undertakings utilising forest products. Full attention was paid to afforestation methods, Soil-erosion control and tending of forest crops.

We would like to express our sincere thanks to all those territorial Forest Officers who helped us to visit their areas, to the Railway and other transport authorities and the rationing authorities in Dehra Dun but for whose co-operation these tours could not have been accomplished so successfully.

Games, Sports, messing and general health

All students of both Colleges are required to take part in Physical training every morning while at Headquarters they have also to take part in games and sports every evening. The regular and active habits that charcterise our courses have led in no small measure to the maintenance of a good general standard of health and even in noticeable improvement in the physique of the students. There have, however, been a few unfortunate exceptions, viz., two students of the Rangers College had to leave College owing to tuberculosis, and two suffered from typhoid. Two students injured themselves, one in the leg and the other in the right hand, while working on field projects but have recovered the use of the limbs.

In the annual tournaments, the Rangers College annexed the Tennis, Football and Volley ball cups while the Officer students won the Hockey and Cricket cups. In the annual sports the Indian Forest College won the team championship and P. B. Kapur of the same college became the individual champion. It is pleasing to record that this year more students took part in athletic sports as compared to the past few years.

In both Colleges Common Messes were maintained and were recognised as an integral part of the general training, bringing about as it does a spirit of comradeship and mutual understanding amongst men drawn from the various parts of the country and the different communities. During the year, the Rangers College successfully adopted the same practice as the Indian Forest College—of the students managing the mess themselves through student Committees, in the interests of the highest possible stand of messing within their resources. With the great demands the course of training makes on their physical stamina, it is essential that the students should be able to feed themselves with good food and adequately. To ensure this the rules of the Colleges were revised to increase the rates of stipends for the students in keeping with the prevailing high prices of commodities and I am glad to be able to say that most of the deputing authorities have sanctioned these revised rates.

Examinations and results

The practice of inviting forest and other officers outside our organisation, officers not directly on our teaching staff and the Research Officers of the Institute was continued, to examine the classes in the final examinations. We are grateful for help and co-operation given by these officers in this connexion in the midst of their pre-occupation with their own duties. I will presently call on the heads of the two Colleges to announce the results of the 1946-48 courses.

I will now present briefly the salient facts regarding the working of the Colleges during the year 1947-48.

Admission of the 1947-48 Courses

The demand for increased facilities for training in forestry necessitated the formation of two Officer classes in the 1947-49 course to which were admitted 54 students and three corresponding Ranger classes with a strength of 111 students Later in the year owing to defections consequent on partition and communal disturbances and (to a small extent) to other causes, the number came down to 43 in the officers classes and 74 in the Rangers classes. The students include nominees of most provinces (except Madras in the case of Rangers only) and quite a number of States. There are a few non-Muslim students originally deputed by Pakistan provinces, and efforts are being made to have them absorbed by one or other of the units of the Indian Union. Owing to these disturbances

again, these classes have not been able to undertake some of the important tours especially in the Punjab and their class room work has also been interferred with to some extent. I am, however, full of hope that by the time they complete their full 2-year course, they would have had as complete and satisfactory a course of training as any of their predecessors.

Accommodation

The Indian Forest College continued to be housed in the western wing in the upstairs of the main building. Small alterations were effected to provide for the instruction of the much larger junior class. Part of the nurses quarters (left behind by the Hospital that was established in New Forest during the war) were renovated for providing additional hostel accommodation. No work could be started by the Central P. W. D., on the new buildings for the College or its hostels.

The Rangers College was run in two locations, two classes in the old premises in Dehra Dun and the other in the New College buildings in New Forest. Considerable inconvenience was unavoidable owing to total cessation of work on the incomplete additional wings to the new College buildings at New Forest. Because of inadequate hostel accommodation, students had to be put two to a room, for which purpose the rooms were not designed or large enough.

Owing to circumstances perhaps beyond their control the Central P.W.D., have been unable to adhere to schedule with regard to every item of the new building programme in New Forest. It will be no exaggeration to say that almost no new work was carried out during the year: and much of this new work in 1947-48 was in connexion with increased accommodation for the Colleges. The housing of the College staff as well as the staff of the Forest Research Institute (which is all on the increase for a good and urgent purpose) has been an extremely difficult problem for the last 2 years and threatens to become more involved every day. The imperative need for permanent hostels at least for the Indian Forest Ranger College for completion of the Indian Forest Range College building and for staff residence and quarters cannot be overemphasised. And I would request you, Sir, to take this matter up at the highest level possible, in order to ensure that these urgent works are completed without further delay.

The difficulties connected with expansion of facilities for forestry training such as accommodation, staff and organisation of tours for a large and increasing number of classes will probably be eased to some extent, if the proposals now actively engaging the Government of India take final shape. It is hoped that very shortly the Central Government will take over the Madras Forest College at Coimbatore and expand it to provide training for two Ranger classes and one officer class every year. This would help to spread the work at two centres, though the courses of studies and standard of training will be identical at both centres. To ensure this, proposals are also in hand to set up research sections (in some branches at least) as a field station of the Forest Research Institute also at Coimbatore.

Conclusion

Before I close I would address myself to the outgoing students. The reputation of these Colleges which has all along been very high is in your hands. We rely upon you to apply to your work in the forests of India that knowledge, zeal, hard work and devotion to duty which I hope you have realised in this course of training are so essential to a successful personal career and in the interests of the national economy. Ours is a profession which does not attract the attention or the applause of the public of the day but on our good work depends not only the welfare of the present generation especially of the vast rural population but of the generations to come. I call upon you, therefore, to undertake your new tasks with all your ability, with integrity and with the knowledge that you work in a good cause and thus uphold the excellent traditions of service established by the forest services of India.

Many of the students for the new 1948-50 course to begin from to-morrow are already with us. I would tell them that they have now set out to join a succession of foresters known for their selfless hard work (mainly for posterity), unobtrusive methods and high standards of professional efficiency. The course of training here will be exacting, the rules and regulations often irksome and the standard of conduct and discipline extremely high. I can only assure you that the hardships and difficulties you will be subjected to, the very full and varied programme of studies you will have to adopt, and the considerable extent of physical effort you will be called upon to undertake are all designed with the one and only object of training you in the next two years into men really suitable for being entrusted with the care of the valuable forest estate of India. I look forward to your willing co-operation in our efforts to equip you fully for the profession of forestry.

Mr. Bhadran then called upon the Principal, Indian Forest College, to announce the results of the 1946-48 course and requested the Hon'ble Minister Mr. Jairamdas Daulatram to award diplomas and present the prizes. Mr. Mathur announced that all the students of the course had successfully completed the course and were to be awarded diplomas of the College. Two of them gained diplomas with Honours, of whom Mr. N. D. Bachketi of the United Provinces passed out first in the class. Mr. Bachketi was also recipient of the prizes for Management and Surveying and Engineering besides being recommended for the award of the Currie scholarship. The list of students in order to merit in passing out and prize winners is given at the end of this report. Mr. Bhadran, then, called upon the Director, Indian Forest Ranger College, to announce the results of 1946-48 course and again requested the Hon'ble Minister Mr. Jairamdas Daulatram to award certificates and prizes. Mr. Chengapa after a short exhortation to the students, announced that all the 54 students forming two classes of the course had successfully completed the course. Two of them gained Honours Certificates and the rest Higher Standard Certificates. It was pleasing to note that in spite of the large size of the classes the standard of education had been satisfactory enough to enable all the students to obtain higher standard certificates. Mr. I. I. Erasmus of Ajmer was the top student of the year and was awarded the Honours gold medal. The list of students in order of merit in passing out and prize winners is given at the end of this report.

The occasion was availed by the Director of Forest Education to announce the award of the Howard Medal for the year 1947 (for the best piece of independent research by a member of the subordinate technical staff of the Institute) to Mr. S. N. Dabral, Silvicultural Research Ranger, for his work on pruning experiments in the young sal. The Hon'ble Minister was pleased to present the same to Mr. Dabral.

At the request of the President, Forest Research Institute and Colleges, the Hon'ble Minister Mr. Jairamdas Daulatram then addressed the convocation. He emphasised the need for greater effort and a new outlook in forest administration and the big task that lay ahead of the outgoing students. He also dilated on the need for enlarging considerably the facilities for forestry training in the country. His speech reproduced below was listened to with rapt attention:—

"It gives me great pleasure to be associated with to-day's function and to have an opportunity of meeting you all, members of the Convocation and other invited guests. I was looking forward to this occasion to meet you all face to face and participate in the ceremony which sets you on the course of trained service in a field of activity which is great value and importance to our country.

2. You have only recently completed your course of training. You have gained all that these centres of training can give you and you are about to enter or re-enter upon the tasks which confront your Province or State. You will, of course, deal with the tasks with ability and knowledge and with the aid of specialised education which this Institution provides. But it is also my hope that not only these qualities will shape your actions in coming time but you will be inspired by a passion to serve the people among whom your lot may be cast. It is the dweller in the rural parts of India who directly or indirectly bears the largest burden of public taxation. It is he who fills the treasury which feeds us all including those who deal with the day to day administration of the country's affairs. For the service of the masses of our country should be dedicated the lives of all of us whose duty and privilege it is to administer the affairs of the country. Free India can never rise to its full stature and freedom can have no meaning for the masses unless the public servants become true servants of the public. However great the intellectual, the academic, the technical qualifications for public service a public servant may possess, he lacks the highest qualification for it if he lacks the qualifications of the spirit of service. It is my hope and prayer that those to whom the diplomas and certificates are being given to-day for specialised technical training will also train hearts to live and work among the people as of the people and not as above the people.

3. You have big tasks ahead of you. Our forests lie largely as untapped sources of stupendous wealth for the nation. We in India have hardly begun to tap that wealth. We must make the forests the hand-maid of both agriculture and industry. The forests must protect our agriculture against the consequences of floods and other elemental forces of nature. Our forests must subserve and feed our industries with the raw materials that they need. Vast potentialities unfold themselves to our view, as we look at what some other countries have done to harness their forest wealth for the people's use. Judged in the context of the agricultural and industrial needs of a nation of 30 crores, this Forest Research Institute and these forest colleges are hopelessly inadequate to meet the situation. We

will fail India if we move with a pace only a little faster than the pace at which the British rulers moved. Not merely double but ten times must be our pace and that too within a limited period of time if the people are to gain and appreciate the fruits of your work. All of us officials or non-officials have quickly to work up that pace and the day should come soon when every square mile of India's forests, which cover one-fourth of its surface, is exploited to its fullest extent in the service of agriculture and industry. Nothing less should satisfy us and for that purpose our administrative machinery should endeavour to adjust itself. Not hundred or two of officers and rangers must fill the classes at our Forest Colleges but thousands in these two and other coming colleges should receive training for utilising our forests and their products to make India richer and happier.

4. I understand that our forest centre at Dehra Dun is probably the largest of its kind in the world. We should plan out its expansion not only for India's coming needs but to make it the best training centre for the whole of Asia. We should invite and welcome to it students from all over the East even as the famous Nalanda University of Bihar drew to itself the students of half the world. Let us not be satisfied with average or even a normally high standard of work. I would wish to look forward to the day when instead of India's sons going to the United Kingdom or the United States for training in forestry, young men from the Universities of these countries should feel that they have something to learn from the forest experts of India and from the Centre which has the potentialities of the Dehra Dun Forest Research Institute.

5. But if we want to move and move faster towards this goal we dare not plan our building programme on the basis of iron and steel and cement and brick. We, who deal with forests need not be ashamed if we dwell as foresters or least in buildings made out largely of materials which the forests can give us. Permanent structures, as has been our experience take a long time. Dehra Dun has waited for long and has seen little progress in the construction of buildings for the expansion of its forest centre. The Institute is experimenting in soil stabilisation or pakki Matti. Let us go on quickly with the research and begin to apply its results before the year is out to carry out our own expansion schemes. When better times come and iron and steel coal can move about in abundance, we may re-construct what we need on a more permanent basis.

6. The forest authorities in India and others who are interested in forests have been planning out a programme of activity for the coming five years. That programme has many items of use and value. It would not be for me on this occasion to deal with all of them nor would it be appropriate to put before to-day's audience more than a few suggestions as to the direction in which some special attention would appear to be immediately necessary. I have just referred to research in **pakki matti.** When there is acute shortage or immobility of steel and coal, the nation must fall back on locally available substitutes for all its building needs. I would therefore wish it were possible for Dehra Dun to supply to the nation within the shortest possible time full experimental data in regard to this new method of construction. I also feel that plans for producing treated timber in quantities large enough to replace steel in a variety of its uses must be pushed through with utmost speed if the country's progress is not to be held up in more than one direction. I have been thinking whether the Dehra Dun Institute may not itself begin to pilot schemes of producing treated timber and put up a small model production centre for its manufacture. While this would only be, as I have said, a pilot scheme, suggestions have been made that a State concern on a magnitude big enough for the country's needs should be set up to produce seasoned timber on a large scale for al its varied uses. It is difficult to say when these suggestions would materialise into a definite project but treated timber, **pakki matti** and other more attractive schemes must not divert the energy of our forest officers from the equally important function of helping in the development of the minor forest products and the rejuvenation of our cottage industries. It is these which bring forest development to the door of the common man. In all our development plans we should not forget the needs of the broad masses and our research must be re-orientated to serve the true needs of the people at large. This research should be primarily in the interest of the masses and designed to make their lives less cheerless and less bleak. The research should be designed to bring health and prosperity within their homes.

7. I have come to feel recently that the Provinces and States would like to share more in the work of research and training in forestry. Until the time is ripe and a larger number of men become available for staffing with the requisite standard many more colleges in the country, I think it may be of value if we could adopt the suggestion of developing numerous field

research stations, scattered in different parts of India designed for specialised research in subjects of local interest. We may also well utilise the Universities of India for a certain type of fundamental research. I would further venture to submit for consideration the suggestion that a method should be found so that those who are dealing with private forests or have otherwise something to do with forests may have some minimum training and education in forestry at the hands of the forest officers in the province. If a workable scheme to this end could be framed our forest policy might come to be implemented in a wider sphere and receive more extensive co-operation.

8. It is necessary under the conditions of responsible Government that our master, the electorate should duly know what is being done. For this there are many ways and I do not propose to deal with all of them in this address. But I feel that there should be far greater publicity of the work which is being done at Dehra Dun and Coimbatore than has at present been possible so far. I think we may well have a system of show-rooms at the railway stations and other suitable public places. We should organise more frequently forest products exhibitions in different provinces and States. Our publications programme ought to be more frequent and extensive. Camera and film should be exploited much more than to-day. The co-operation of the weekly press should be sought more assiduously. A special Publicity section ought to be attached to the Forest Department. Other methods may also be availed of to put our forest work before those who should know it. Thus shall we have discharged our duty and thus will the people be given what is their due.

9. May I, in conclusion, wish to all those who are receiving their Diplomas and Certificates to-day a career of future promise from their personal point of view and also, may I add, of service to the peoples. Any career which lacks the latter element is a misfit with the era of freedom. It is also a misfit with the Department you will be responsible for. Let us not forget the association of the forests with the traditions of our nation. It was in the repose of the forests that the Rishis of old lived a life of selfless and service and, reflecting on the fundamental problem of happiness discovered its solution in the Gita's formula of disinterested duty done for the welfare of others. It was in the forests of India that men of the spirit practised and preached this eternal law of a happy life. It is the forests of India, which still echo with the stories of Rama and Sita, the stories of a ruler of men like you, who made even his domestic life and the dignity of his own queen subject to the requirements of public opinion. So let the modern workers in the forest catch a little of the true spirit of the forest and participate in the inheritance not only of the material but also the spiritual wealth of the 'Aranyas' of old and let service, in its real sense, be the guiding principle of their official career. This is what your own people expect from you. It is my fervent hope that you all will fulfill their expectation.

"Jai Hind."

The Inspector General of Forests, Mr. A. P. F. Hamilton, then thanked the Hon'ble Minister for coming to the convocation in the midst of his various other and important pre-occupation and proposed a hearty vote of thanks to the Minister.

The convocation ended with 3 calls for 'Jai Hind' from Mr. N. D. Bachketi—the student who passed out top from the Indian Forest College 1946-48 Course.

(2) Indian Forest College Dehra Dun

1946-48 COURSE.

(In order of merit).

HONOURS.

1. Mr. N. D. Bachketi. U.P

   Awarded.—

   1. College Prize for Management.
   2. College Prize for Engineering and Surveying.
   3. Currie Scholarship.

2. Mr. J. N. Pandey. Bihar.

   Awarded.—

   1. Hill Memorial Prize for Silviculture.

PASS DIPLOMA.

3. Mr. C. V. Konda Reddy. Madras.

Awarded.—

1. Principal's Prize for the Best All-Round student.

4. Mr. P. K. Roy. Bengal.

Awarded.—

1. College Prize for Botany.

5. Mr. P. K. Karamchandani. Bombay.

Awarded.—

1. College Prize for the Best Practical Forester.

6. Mr. S. D. Tiwari. C.P.

Awarded.—

1. Special Prize for Promise of Original work.

7. Mr. P. G. Deshmukh. Gwalior.
8. Mr. B. S. Bhathena. Bombay.
9. Mr. G. R. Mavin Kurve. Bombay.
10. Mr. V. N. Nadgir. C.P.
11. Mr. K. K. Acharya. Junagadh.
12. Mr. D. C. Sharma. C.P.
13. Mr. C. L. Mohapatra. Orissa.
14. Mr. M. P. Das. Orissa.
15. Mr. A. M. Mahmood Hussain. Madras.
16. Mr. B. R. Gupta. Kashmir.
17. Mr. Balaram Paul Baidya. Nepal.
18. Mr. D. N. Sinha. Bihar.
19. Mr. D. D. Sharma. Sirmoor.
20. Mr. H. H. Pandeya. Rewa.
21. Mr. Md. Abdul Aslam. Madras.

Indian Forest Ranger College Dehra Dun

1946-48.

(In order of merit).

HONOURS.

1. I. I. Erasmus. Ajmer.

Awarded.—

1. Honours Gold Medal.
2. Hazarika Memorial Medal.

2. Mr. S. N. Pathak. U.P.

Awarded.—

1. Silver Medal for Forestry.
2. Fernandez Gold Medal for Forest Utilization.

HIGHER STANDARD.

3. Mr. G. S. Bhat. Bombay.

Awarded.—

1. Silver Medal for Forest Engineering.

4. Mr. B. K. Tikku. Kashmir.

Awarded.—

1. Silver Medal for Botany.
2. McDonnell Silver Medal.

5. Mr. N. C. Bose. Mayurbhanj.

Awarded.—

1. "Indian Forester" Prize.

6. Mr. R. D. Rawal. Punjab.

Awarded.—

1. Director's Prize.

7. Mr. R. K. Sanyal. Bihar.
8. Mr. K. P. Srivastava. U.P.
9. Mr. R. G. Sukhramani. Sind.
10. Mr. C. L. Bhasin. N.W.F.P.
11. Tej Ram. Kashmir.

Awarded.—

1. William Prothero Thomas Prize.

12. Mr. Durga Das. Jubbul.
13. Mr. L. H. Benakatte. Bombay.
14. Mr. A. S. Rathore. U.P.
15. Mr. P. P. Sen. Bihar.
16. Mr. V. B. Umachigi. Bombay.
17. Mr. S. C. Pandey. U.P.
18. Mr. H. N. Patil. Bombay.
19. Mr. P. K. Majumdar. Bengal.
20. Mr. T. M. Naidu. Bastar.
21. Mr. B. B. Khisha. Bengal.
22. Mr. K. D. Muthana. Coorg.
23. Mr. L. M. Panda. Orissa.
24. Mr. B. S. Belwal. Bombay.
25. Mr. R. N. Khandkar. Kolhapur.
26. Mr. H. M. Gidwani. Sind.
27. Mr. N. R. Patil. Bombay.
28. Mr. G. P. Srivastava. C.P.
29. Mr. P. K. Bhatnagar. C.P.
30. Mr. R. C. L. Srivastava. Datia.
31. Mr. H. P. Haldar. Bengal.
32. Mr. R. P. Akhori. Bihar.
33. Mr. G. R. Karnik. Baroda.
34. Mr. Ved Prakash. Punjab.
35. Mr. S. S. Hiran. Mewar.

36. Mr. K. T. Ganapathy.	Coorg.	46. Mr. P. K. Bhoralee.	Assam.
37. K. G. Gouse.	Hyderabad.	47. Mr. P. D. Nima.	C.P.
38. Mr. G. S. Reddy.	Hyderabad.	48. Mr. S. K. Misra.	Ajaigarh.
39. Mr. Bishan Chandar.	Gwalior.	49. Mr. M. A. Makki.	Kashmir.
40. Mr. V. B. Singh.	U.P.	50. Mr. R. K. Biswas.	Bengal.
41. Mr. V. N Deshmane.	Bombay.	51. Mr. P. B. Vyas.	Kutch.
42. Mr J. N. Mathur.	Jaipur.	52. Mr. Akram Khan.	Afghanistan.
43. Mr. M. A. Khan.	Bihar.	53. Mr. G. D. Srivastava.	Rewa.
44. Mr. S. C. Deo.	Rairakhol.	54. Mr. M. A. Faruqi.	Bharatpur.
45. Mr. Gul Mohd. Khan.	Afghanistan.		

(3) The Nandhaur Valley Tramway

By

Ch. ALAMGIR KHAN

G|848|UP.—Nandhaur valley makes up a considerable portion of Haldwani forest division of the United Provinces. Government sanctioned a locomotive tramway scheme to improve the means of transport of forest produce and the 15½ miles of the track were completed by 1926. The paper describes all aspects of the work and management. The tramway has brought in an average yearly surplus of Rs. 32,500.

Nandhaur is a small river which winds its way through the lower ranges of the Himalayas and finally leaves the hills at Muchlibund about 2½ miles above 'Chorgalia' which place is about 12 miles East of Haldwani Town and the head quarters of forest territorial range. This hilly tract is known as the Nandhaur valley and forms a considerable portion of the Haldwani Forest Division.

In 1923 when carts were only means of transport. and extraction of forest produce, scheme for construction of a locomotive tramway between Muchlibund at the mouth of the Nandhaur river and Lalkua on the R. K. Rly. (now O.T.R.) was submitted to the Government in order to tap the forest resources of the Nandhaur Valley and bring them as quickly as possible out of the forest to a railway station within the short working season of all Forest work. This scheme with slight alterations was sanctioned by Govt. (vide C. F. Western Circle's No. 705|XIII-9c dated 15-10-1924). The scheme laid down the construction of a 2' gauge steam tramline, over a length of 15½ miles at a capital expenditure of Rs. 1,81,000 inclusive of locomotives, rolling stock, buildings and all other items connected with its construction except royalty on timber which would be utilised for sleepers, bridges and other woodwork consistent with its construction. This was estimated at Rs. 9,000|-.

Construction on the tramline was commenced in November 1924 and the 1st. 12 miles were completed by April 1925 while the remaining 3½ miles were completed during the cold weather of 1925-26.

The line crosses two fairly big rivers, the Gaula, ¾ miles wide and Sukhi about 300' wide; several small nallas are also crossed. All these rivers and nallas remain dry during winter and summer. Crossings over these portions are made by temporary crib pier bridges at points where the main water streams are likely to flow during the winter rains while the rest is embanked by earth. No permanent bridges have been constructed as the cost would be prohibited and the initial scheme was made only for a period of 8 years, thus it was not thought proper to construct anything of a permanent nature which later would not be of any use to the forest department. Embankments of rivers and nallas and temporary bridges are consequently constructed yearly during the beginning of the season and the track relayed over these portions. The difference in level between Lalkua and Muchlibund is 390', giving an average gradient in favour of the load of approximately 25' per mile. There are however two reverse gradients of 1 in 500 and 1 in 666 over two short lengths which do not hinder the traction power of locomotives with load. The steepest gradient in favour of the load is 1 in 48, near Chorgalia.

Apart from the main line to Muchlibund a branch line from a point below Sela (about 10 miles from Lalkua) was laid to tap the area of Seljam, this was dismantled after serving its purpose and is not in use at present. In 1930-31 the whole track from Horai (6½ miles from Lalkua) to Munchilbund was dismantled and relayed upto Chungadh. The main line was now from Lalkua to Horai thence East North to Chungadh, a distance of 14 miles with a short feeder line of 1½ miles from Chungadh to Karakot and ¾ miles for extraction of Khair billets. This construction cost Rs. 20,500|-. After all fel lings for which this line was laid, had been completed the line was dismantled upto Raikhal which is about 3½ miles from Horai—and the original line upto Chorgalia was relayed. In 1945-46 as feelings had once again been shifted to the hilly portions of Nandhaur the track from Chorgalia to Muchlibund (2½ miles) was again relayed. Material of the portion between Raikhal and Shernala was utilised for this. To-day the line runs upto Muchlibund 15½ miles and a branch line from Horai to Shernala (2 miles).

LOCOMOTIVES—Originally one locomotive of 40 H.P. was purchased for 14,000|- in 1925 and a second in 1926 of the same type.

In 1930 a third locomotive of a heavier type with double the capacity of the former ones and of 60 H.P. was purchased at a price of 19,500|-. No other locomotive has been purchased since and work with these is being carried out after getting parts repaired and overhauling done every year during the off season.

ROLLING STOCK—The rolling stock consisted of (1) 40 small trucks taken over from the Sarda Valley Scheme carrying capacity 40 cft. (1½ tons). (2) 4 large 5 ton bogie wagons second hand purchased from Nepal @ Rs. 600|- each plus freight. (3) 32 small platform trucks second hand purchased from Nepal @ 130|- each plus freight, carrying capacity 2½ tons each. (4) 8 small timber platform trucks for carrying large logs transferred form the Dehradun tramline which was dismantled.

As this heterogenous train of various kinds of trucks with different heights of coupling proved unsatisfactory, 15 bogie trucks of 5 ton capacity were bought in 1925 and 1926 @ 460|- and 900|- each f.o.r. Calcutta. This was original rolling stock later 10 ton bogies and 13 ton Bogas were added and now we have:—

20—5 ton bogies,
4—10 „ „
4—13 „ „
3—Juttas for carrying large and long logs
8—Khair Thelas
8—trucks which are shunted by hand and only

used for taking material short distances for constructional use. Apart from above there are frames for 20 Tulas and 5 'Julas." Still in soil, but not used.

BUILDINGS—Under the original scheme the following buildings were constructed with corrugated galvanised iron sheets:—

1. Engine shed (to hold 2 engines)
2. Dispensary
3. Chargehand Quarters
4. Store
5. Six rooms for the loco and workshop staff.

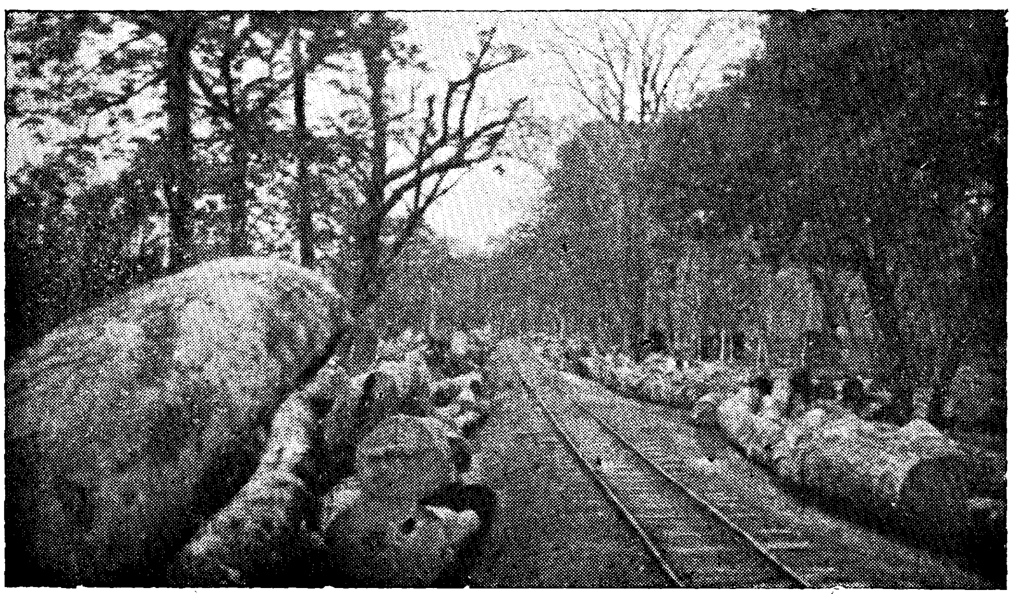
Later in 1938 the small store room was supplemented with a large Store Godown built with corrugated iron galvanised sheets and Angle irons, this was essential as the original store room was not adequate to hold the growing store articles. Another 'Pucca' Quarter for the Store Keeper and one attached officer of the permanent staff was built of burnt bricks. A stone masonry dispensary and Quarter for the Tramway Doctor was constructed and the old "Chappar—pharra" hut of the Officer-in-charge of the tramway was replaced by a good double storied bungalow made of burnt brick and with reinforced concrete roof. These items although they looked luxurious when compared with the very crude grass-cum-planks houses in which the pioneers of the tramway had to pass most of their time nevertheless they were a dire necessity for the tramway staff who had to pass most of the time in this malarious place.

It may be added that although big steps have already been accomplished in looking to the amenities of the tramway staff still some more quarters even if they be of corrugated sheets with pucca concrete floors need to be erected for the labour who still have to put up on damp floors and thatched buts.

A GENERAL IDEA REGARDING WORK AND WORKING OF THE TRAMWAY

As already mentioned previously the hinterland of Chorgalia, which made up mountanious region of the Nandhaur, had to be exploited and in order to facilitate speedy and economic means of transport of all forest produce the tramway was initiated. The tramway therefore is totally used for transport of all forest produce from the Nandhaur Valley and other forest areas con veniently situated within reach of the various loading stations selected along the line. There are at present the following tramway stations:—

1. Terminus and Head Quarter—Lalkua (linking up the N. V. Tramway with with the O.T.R.)



A tramline for transporting timber from Lalkua depot.

Hon'ble Bashir Ahmed, Forest Minister, U. P., inspecting depot at Lalkua.

2. Dauli 5 miles from Lalkua.
3. Horai 6½ miles from Lalkua.
4. Shernala 8½ miles from Lalkua to the east of Horai (branch line)
5. Sela 10 miles from Lalkua
6. Lakhmanmandi 12 miles from Lalkua
7. Chorgalia 13 miles from Lalkua
8. Muchlibund (Terminus) 15½ miles from Lalkua.

MANAGEMENT—The working of the tramway is in charge of a gazetted forest officer under the Divisional Forest Officer of the Haldwani Forest Division. He is assisted by a permanent staff of 2 assistants, one Clerk, one Store-keeper. During the season, i.e., from October to June temporary staff of Engine drivers, firemen, khalasis, watermen, carpenters, blacksmiths hammerman, blowboys, chaukidars, brakesmen and truck fitters are employed.

LOCO AND WORKSHOP STAFF—A head mistry is kept throughout the year to look to the repairs of all locomotives and trucks, while the track is maintained by 6 gangs of coolies usually of a strength of 10 men and one jamadar each; apart from this about 2 gangs are kept for diverse other jobs connected with the tramway.

The distribution of work at present is as given below:—

1. Officer-in-charge—Management of all works.
2. One Assistant—Supervision of Tramway yard and stock.
3. Second Assistant—In charge of all labour and supervision of the track.
4. Clerk—Maintenance of all records, correspondence and accounts.
5. Store-keeper—In charge of stock.
6. Head Mistry—Supervision of and repair of locos and trucks and also repair of telephone instruments. He is assisted by an assistant and a khalasi.
7. 2 loco drivers with a contingent of two watermen, 2 khalasis and two firemen.
8. 2 Brakesmen who act as pointsmen—train guard and shunters.
9. 2 bogie fitters assisted by two coolies each.
10. One or two carpenters depending upon the extent of work assisted by a coolie each. They repair all wood work of bridges—trucks and other woodwork required in the maintenance of the tramway.
11. Six permanent way gangs and two floating gangs of labourers.

Previously station masters, pointsmen and S.P.W.I. were maintained but now these have been given up and strictest economy as regards staff is enforced.

EXPORT—At each loading station timber is loaded into the trucks by the owner of the timber and freight charged according to a schedule of rate for each commodity. The contents of each wagon with measurement and freight is entered on a 'rawanah' is used by an Export Muharrir who hands all such rawanahs to the Train-in-charge who in turn hands them to the check muha-rrir at Lalkua. The check muharrir checks all trucks and allows the timber to be unloaded by the owner. All accounts are maintained in the Tramway Office. At Lalkua paraos are allotted to various purchasers of the forest produce and they stock all their material in such areas. No passengers are allowed to travel on the trains except tramway labour on empty wagons and under the orders of the Officer-in-charge. Attached is a statement showing yearly the quantity of forest produce which the forest tramway has handled. (Schedule 2)

LABOUR—The labour rates and prices of material have, since the last war, increased greatly. By way of illustration it may be mentioned that earth work which could be done @ Rs. 9|- per %o cft. is today done at about 27|- per %o cft. An ordinary labourer's wages were about Rs. 12|- per mensem and today it's 35|- while the rates of freight have not increased to the same extent. Schedule (3) gives a statement of rates enforce in 1926, 1940 and 1946 just to give an idea of the difference in rates previously and now. It may however be mentioned that for the season 1947-48 the rates have been revised and a slight increase made the new rates are given separately under schedule (4).

FINANCIAL RESULTS—The Capital Expenditure incurred upto 30th. June 1947 has been Rs. 2,23,418|- (Schedule (1) gives the details of Capital Expenditure) while the running expenditure upto financial year ending March 1947 is Rs. 8,67,772|- as against a revenue of Rs. 9,71,076|- upto the end of March 1947, on a surplus of Rs. 7,47,658|- including the Capital Expenditure with the running expenses. Thus it will, be seen that the Tramway has paid up its capital and given a surplus of about Rs. 7,48,000 - or an average of about Rs. 32,500|- per annum surplus. The tramway, as all businesses, has had some set backs which were in 1938-39 when there was a deficit of Rs. 2,297|- and again in 1945-46 when there was a deficit of Rs. 19,687|-. This was due to an unusually small amount of material available for being carried by the tramway and exceptionally heavy expenditure on replacements and repairs, Last year i.e., during the season 1946-47 (1st

April 1946 to 31st March 1947), revenue was Rs. 62,135|-, as against an expenditure of Rs. 40,027|-, giving a surplus of Rs. 22,108|-. During all the other years there have been surpluses ranging between 5,659|- and 1,07,373|- fluctuating with the amount of traffic available. Last season i.e., from July 1946 to end of June 1947, the revenue was Rs. 94,337|- and expenditure during the same period Rs. 39,245|- giving a surplus during the working season of Rs. 55,092|-.

NECESSITY FOR THE TRAMWAY—I quote the reports of Mr. E. A. Smythies, Conservator of Forests, Western Circle in 1926. "The other benefits (apart from the direct financial results) of the tramline are most important. To the timber contractors who buy the coupes immediately served by the line, the advantages are obvious. Instead of having to give cash advances to cartmen, with the danger of their decamping in the middle; instead of the perpetual struggle to get sufficient carts (since supply in the rush season has never adequately met the demand), and the possibility of rising prices as the demand becomes more acute; instead of possible losses of timber in transit, and various other disabilities, contractors are now assured of swift and certain export of their timber, they know the rates per cft. before they bid at the auctions and that these will not later, they pay no advances but on the contrary, with the system of sleeper supply to the railways, are given full credit for the value of all sleepers delivered by them as soon as the sleepers are passed, thus easing the finance of their export considerably. These direct benefits must favourably influence the biding at auctions. But the influence of the tramline extends far beyond the timber coupes immediately in contact with it. The removal of 1,27,000 ton miles of freight by tramline resulted in the unprecedented fact of a plethora of carts all over. In the division, the cartmen were no longer lords of the situation, and instead of contractors fighting for the carts, the carters were fighting for the contractors, and carting rates came down appreciably in consequence. This again must influence bidding at the auctions to some extent, and thereby favourably affect the revenue of the division. This report was made in the 'Cartage'. Now since 1940-41 carts have been replaced by motors in areas where motor roads for export have been constructed and the position has changed—but nevertheless the benefits and influence of the tramway on rates of export by other means still exists. Mr. D. Davis, Conservator of Forests, Western Circle in his note last year writes—

"The tramway was started over 20 years ago when there was no motor transport in the forests and forms of transport were insufficient and expensive. It has undoubtedly proved most useful to contractors and a source of considerable profit to the forest department. Even so there have always been some contractors who for one reason or another would have preferred to make their own arrangements for transport.

Since the advent of motor transport there are undoubtedly more contractors who would prefer to use motor lorries all the way to railhead rather than utilise the tramway. This particularly applies to those who own their own lorries. If we could be certain that all contractors would prefer to use lorries, that sufficient lorries would be available and that freight by lorry would not be more expensive than by tramway, then I would say that the tramway should be closed at once.

But available information shows that there are not and are unlikely to be sufficient lorries and that freight by hired lorries would almost certainly be more than by tramway. Only a few of the bigger contractors own their own lorries. A considerable number of the smaller contractors will never be able to afford lorries of their own and if the tramway is closed will have to depend entirely on hired lorries. In the opinion of the D.F.O. the presence of the tramway tends to keep rates by lorry down to a reasonable figure. The average tramway freight is at present about 3.7 pies per cft. per mile. To this must be added the extra cost of loading and unloading which is necessary for material taken by the tramway, and the figure is then about 4.7 pies per cft. per mile. Rates by hired lorries this season are (a) on routes where the tramway does not compete:—

1. In plains 6 pies per cft. per mile,
2. In hills 9 pies per cft. per mile

(b) on routes where the tramway competes 4 pies per cft. per mile. This shows the effect of the tramway in keeping down rates. Without the competition of the tramway it is fairly certain that the rate of 4 pies under (b) would rise to 6 pies or more".

Apart from the above benefits it would be of interest to mention that if only motor lorries were employed in moving this heavy traffic direct to railhead it would have meant that in 5 months i.e. 15th January to 15th May and a working month being equivalent to 25 days only, 16 buses would be employed for sawn timber about 9 for logs about 17 for fuel (they being able to make 2 trips per day) and 4 for charcoal (period in this case being of 3 months and one lorry can carry 40 bags only.) Thus 46 lorries would be required daily which are not forthcoming at present; moreover to work these—

16,000 gallons of petrol for timer at 8 gallons per day per lorry, 26,000 gallons for fuel at 3-gallons per trip per day (2 trips) and 1,800 gallons for charcoal at 6 gallons per day per lorry, (logs are still carted to the tramway station and therefore not accounted for), i.e., 43,800 gallons of petrol would be required out of which probably 10,000 gallons is used in any case for bringing timber, etc. to the tramway stations but the balance of 33,800 gallons would have to be further supplied. With the tramway functioning this big amount of petrol is being saved and legetimately, as every drop of petrol that can be economised for more essential purposes of the nation must be made; which it would be a pity to lose for transport of timber and especially when an alternative means of transport, viz., tramway is at hand.

CONCLUSION—Justification of any business undertaking can only be if some return is shown for the expenditure incurred and this can only be, with respect to the N. V. Tramway, if traffic be to the extent of about 3,00,000 cft. of timber which would give a revenue of about Rs. 60,000 at a flat rate of 0-3-0 per cft. and this should be supplemented by traffic of logs—fuel—charcoal and other miscellaneous forest produce that may bring in another Rs. 10,000 i.e., if a total revenue of Rs. 70,000 per annum can be guaranteed the tramway will be able to pay its way through and show some profit. With better times when prices of commodities and wages of labour are more favourable higher profits are possible. A true picture of traffic that will be available for handling by the tramway in the future will only be possible when the new working plan is known—nevertheless for the next two years it is hoped that the tramway will still be able to add some of its profit to the Government treasury and justify its existence.

DETAILED ACCOUNT OF CAPITAL EXPENDITURE TO END OF 1946-47

SCHEDULE (1)

Sl. No.	Detailed head of expenditure		Amount
1.	Permanent Way	......	1,14,900
2.	Sidings	......	8,592
3.	Locomotives	......	47,524
4.	Wagons	......	28,123
5.	Crossings	......	2,743
6.	Water tank	......	5,806
7.	Buildings	......	7,003
8.	Tools	......	212
9.	Miscellaneous	......	8,515
	Grand Total	......	2,23,418

STATEMENT SHOWING YEARLY THE FOREST PRODUCE HANDLED BY THE N. V. TRAMWAY

SCHEDULE (2)

SPECIES

YEAR	Sawn timber Cft.	Logs Cft.	KHAIR billets Mds.	Fuel Cft.	Charcoal Bags	Stone Bogies	Katha Mds.	Bamboos Scores
			11 Million					
1925-26	2,50,000	—	Lbs.	—	—	—	—	—
1926-27	4,82,617	—	1,27,078 Mds.	—	920	—	—	—
1927-28	5,67,309	88,957	74,782	1,30,300	7,833	—	—	—
1928-29	4,36,389	2,085	91,250	—	10,766	51	—	—
1929-30	4,57,142	5,434	91,469	2,850	—	—	435	—
1930-31	2,77,228	3,296	1,07,940	13,250	—	—	—	—
1931-32	Figures not available							
1932-33	3,49,585	90,384	1,47,171	90,000	—	—	116	—
1933-34	2,31,455	5,525	1,45,343	1,89,300	—	—	—	—
1934-35	3,08,458	24,710	1,33,402	8,05,060	—	—	—	240
1935-36	Figures not available							
1936-37	94,310	4,460	1,35,850	1,74,080	—	—	—	—
1937-38	2,26,205	3,449	59,958	4,66,640	—	—	—	—
1938-38	1,80,975	1,307	—	6,81,480	—	—	—	—
1939-40	1,80,649	53,845	—	6,87,000	—	—	—	—
1940-41	3,08,022	17,876	—	8,01,440	—	—	—	—
1941-42	9,31,093	55,945	—	3,06,480	—	—	—	—
1942-43	2,84,391	52,117	—	3,93,300	1,499	—	—	—
1943-44	4,38,385	76,929	—	6,94,900	1,646	—	—	—
1944-45	4,37,276	37,786	—	17,25,823	—	—	—	—
1945-46	2,11,988	57,680	—	26,400	515	—	—	—
1946-47	2,06,487	1,02,654	—	4,45,623	12,102	—	—	—

SCHEDULE OF RATES OF TRAMWAY FREIGHT FOR 1945-46.

SCHEDULE (3)

Description of goods	Dauli	Horai	Sher nala	Raikhal	Sela	Lakh man man di.	Chor galia	Near Much libund	Re marks
1. Sawn timber of any species and any dimension including Sillies, Gattas and Dofars sawn or axed except B.G. M.G. and N.G. track sleepers of of the dimension allotted to different lots	0 1 6	0 2 0	0 2 6	0 3 3	0 3 6	0 4 3	0 4 6	0 5 0	P.Cft.
2. B.G., M.G. and N.G. and special sleepers of sal and other species	0 1 3	0 1 9	0 2 3	0 3 0	0 3 3	0 4 0	0 4 3	0 4 9	,,
3. Logs of any species of 3' girth and over and any length	0 1 6	0 2 0	0 3 0	0 3 6	0 3 9	0 4 6	0 5 0	0 5 6	,,
4. Logs and ballies of any species and any length under 3' girth and tors	0 1 0	0 1 6	0 2 6	0 3 0	0 3 3	0 4 0	0 4 6	0 5 0	,,
5. Patties and sirwas 4' to 7' long	1 8 0	2 0 0	3 0 0	3 8 0	4 0 0	4 8 0	5 0 0	5 8 0	,,
6. Bamboos	0 3 0	0 4 0	0 5 0	0 6 6	0 7 6	0 8 0	0 9 0	0 10 0	P. Score
7. Fuel	4 8 0	6 0 0	7 0 0	7 8 0	7 8 0	8 8 0	9 0 0	8 8 0	per 5
8. Pharras fit for fuel	5 0 0	6 8 0	7 8 0	8 0 0	8 8 0	9 0 0	9 8 0	0 10 0	ton bogie, 10 ton bogies will be charged at 50% more.
9. Other pharras	7 0 0	8 8 0	9 8 0	10 0 0	10 8 0	11 0 0	11 8 0	12 0 0	,,
10. Charcoal	0 1 9	0 2 3	0 3 0	0 3 3	0 3 6	0 4 0	0 4 6	0 5 0	,, per sack load
11. Katha (Khair)	0 3 0	0 4 0	0 5 0	0 6 0	0 6 6	0 7 6	0 8 0	0 8 6	,,
12. Miscelaneous			Rates on application						
13. Rations and other stuff from Lalkua	0 3 0	0 4 0	0 4 6	0 5 6	0 6 0	0 6 6	0 7 0	0 7 6	per maund

Note :—Tramway freight on fuel brought in lorries from Jaulasal and Nandhaur Ranges and loaded at Chorgalia, Lakhmanmandi or Shernala tramway siding will be as follows:—

Shernala 3|- per 5 ton bogie.

Lakhmanmandi 4|4|- per 5 ton bogie.

Chorgalia 5|- per 5 ton bogie.

This reduction in freight will not apply to fuel from any other Ranges or to fuel from Jaulasal and Nandhpur Ranges delivered by any means of transport other than by lorries. Freight on inferior fuel will be charged at 80% of the above rates.

Pharras cut into fuel billets will be charged at fuel rates.

SCHEDULE RATES OF TRAMWAY FREIGHT FOR 1940-41

SCHEDULE (3)

Description of goods	From Horai station	From Sher nala station	From Sela station	From Dolpokhra station	From Porjia station	From Jam-pokhra station	Remarks
1. Sal sawn timner (except small karies as noted below) and Sal logs of 3' girths and over and M.G. sal sleepers	0 1 3	0 2 0	0 2 6	0 2 9	0 2 0	0 1 9	P. Cft.
2. Sal karies below 19" length. Any sal sawn timber 6' and below in length, irrespective of girth	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
3. All other timber logs	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
4. Kanju logs	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
5. Sain and & Haldu scantlings below 19" girth & 9" length & below. Haldu planks & sillies not more than 9' in length & more than 28" girth	0 1 0	0 1 6	0 2 0	0 2 3	0 1 6	0 1 6	„
6. Sain & Haldu (sawn timber)	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
7. All other Miscll. species (sawn timber)	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
8. Ballies under 3' girth & tors (Sal & kokat)	0 1 0	0 1 9	0 2 3	0 2 6	0 1 9	0 1 6	„
9. Patties	1 8 0	2 0 0	2 8 0	2 12 0	2 0 0	1 12 0	p. cent.
10. Bamboos	0 4 6	0 4 0	0 5 0	0 5 6	0 4 0	0 3 6	*P. score*
11. Fuel	4 3 0	4 15 0	5 0 0	5 8 0	5 8 0	5 8 0	per 5 ton bogie. 10 ton to be charged 50% more.
12. Charcoal	0 1 6	0 1 9	0 2 3	0 2 6	0 2 6	0 2 6	per sack load
13. Pharras	4 0 0	4 13 0	6 0 0	6 10 0	4 13 0	4 3 0	per sack load
14. Khair (Katha)	0 2 0	0 3 0	0 3 9	0 4 0	0 3 0	2 6 0	per sack load
15. Miscellaneous	Rates on application.						

SCHEDULE OF RATES N. V. TRAMWAY LALKUA DURING 1926

SCHEDULE (3)

Description of goods	SIDINGS		
	10 miles DOLPOKHRA per cft.	Sela 10 miles KANDI SARAK per cft.	9 miles SUKHI per cft.
1. All sawn timber and logs over 3' girth	0 3 3	0 3 0	0 2 9
2. Ballis (under 3' girth and tors) .. Sal Kokat	0 2 9	0 2 6	0 2 0
3. Pattis	Rs. 5 0 0 P.C.	Rs. 0 0 0 P.C.	Rs. 5 0 0 P.C.
4. Bamboos	0 6 0 per score	0 6 0 per score	—
5. Fuel	Rs. 18 0 0 per stack of 600 C.ft.	Rs. 16 0 0 per stack of 600 C.ft.	Rs. 12 0 0 per stack of 600 C.ft.
6. Charcoal	0 4 6 per sack	0 4 0 per sack	0 3 6 per sack

SCHEDULE OF RATES OF TRAMWAY FREIGHT FOR 1947-48

To Lalkua O. & T. Railway

SCHEDULE (4)

Class of Produce	Muchli bund R.a p.	Chor-gaiia Rs.a.p	Lakhman maudi Rs. a. p.	Sela Rs. a. p.	Raikhal Rs. a. p.	Sher Nala Rs. a. p.	Horai Rs. a. p.	Dauli Rs. a. p.	Remarks
Sawn timber incl. sillis, giltas, dofars and excluding sleepers ..	0 6 0	0 5 6	0 5 3	4 4 6	0 4 3	0 3 6	0 3 0	0 2 0	per ft.
Sleepers of all description ..	0 6 0	0 5 6	0 5 3	4 4 6	0 4 3	0 3 6	0 3 0	0 2 0	„ „
Logs of 3' girth ..	0 6 6	0 6 0	0 5 6	0 4 9	0 4 6	0 4 0	0 3 0	0 2 6	„ „
Logs and ballies below 3' girth and tors ..	0 6 0	0 5 0	0 5 0	0 4 3	0 4 0	0 3 6	0 2 6	0 2 0	„ „
Pattis and sirwas ..	6 8 0	6 0 0	5 8 0	5 0 0	4 8 0	4 0 0	3 0 0	2 8 0	„ %
Bamboos ..	0 12 0	0 11 0	0 10 0	0 9 6	0 8 6	0 7 0	0 6 0	0 5 0	„ Score
Fuel ..	11 8 0	10 0 0	8 8 0	7 8 0	7 8 0	7 0 0	6 0 0	4 8 0	„ 5 ton bo-
Pharras fit for fuel ..	12 0 0	11 8 0	11 0 0	10 0 0	9 8 0	9 8 0	8 8 0	7 0 0	gie, 10 ton bo-
Other pharras ..	14 0 0	13 8 0	13 0 0	12 8 0	12 0 0	11 8 0	10 8 0	9 0 0	gie will be
Charcoal ..	0 6 0	0 5 6	0 5 0	0 4 6	0 4 3	0 4 0	0 3 3	0 2 9	Per Bag
Katha ..	1 0 0	0 14 0	0 13 0	0 11 0	0 10 0	0 9 0	0 8 0	0 6 0	„ „
									charged at 50% more
Miscellaneous ..	Rates on application								
Rations and other food-stuffs from Lalkua ..	0 7 6	0 7 0	0 6 6	0 6 0	0 5 6	0 4 6	0 4 0	0 3 0	„ Maund

The Use of Semi-Portable Saw Mills in Departmental Timber Operations

By
Mr. L. Rynjah, Assistant Conservator of Forests, Assam.

G|9131|As.—In the hectic days of the Japanese invasion of Burma this project of supplying sawn timber for the army in India was got through, in the admittedly backward tract of Rangapahar. The experience provides valuable lessons for all-time work.

INTRODUCTION.—

THE word portable saw mill is a misnomer and the forest officer in Assam, who first heard this term during the war, has yet to see his forests being operated by that robot type of logging and sawing machinery which is the subject matter of magazines dealing with the American timber industry and of conversation by less informed and experienced people! But until that stage is reached we, in Assam, have discovered as a result of the war, the value of the lighter and 'more-portable' type of saw mill capable of dealing with all but the biggest of logs. The following article deals with such a type of mill, around which has been built up a departmental exploitation and re-planting organisation which is serving as a model for other areas.

P. D. STRACEY,
Senior Conservator Of Forests, Assam.

1. A departmental timber operation is nothing new in the Forest Department of India, but the operation now described has some special features which might be of interest to Forest Officers in general in India and it is with this idea that this account is published in the Indian Forester.

2. Burma was invaded by the Japanese early in 1942 and as a result of the retreat of the Allied Forces into Assam, through Manipur, Road or Dimapore became an important base for the storage and supply of war materials to the field of operation. From being no bigger than a small village in prewar days, notorious for its unhealthiness, it became overnight a crowded and busy area, connected with Kohima, Headquarters of the Naga Hills, and Manipur State by a narrow motorable road forming the exit route from these remote places. With troops pouring in from all directions and thousands of refugees evacuating from Burma, everything was in a state of confusion. Due to the apprehended invasion of the country food was scarce and the civilian population had evacuated to safer places. Under such conditions, the Army required huge quantities of forest produce, and timber in particular, for housing troops and for maintaining the line of communication to forward positions. Though the Assam Forest Department was not then in its full stride as far as production of materials for the war-front was concerned, it would have been possible to move available materials upto Manipur Road if the communications bottle-neck could have been broken. There was no all-weather road connection with the outside world and the single line M.G. Railway system could not cope with even a fraction of the war supplies and troops pouring in under the circumstances it was decided to convert the timber needed on the spot, and the work was entrusted to the Working Plan Officer, Mr. C. S. Purkayastha, as being the only man available at the time.

3. The Army was utilising all available tree-cover as camouflage and there was a considerable amount of restriction over their removal, while in the interest of secrecy no civil population were permitted to work in areas too close to the military camps. In the circumstances, a camp had to be selected within a reasonable distance of the base in the Rangaphar Reserve which it was contemplated to exploit, and a site was chosen on the banks of the Dhansiri River some 5 miles from Dimapore. A handful of temporary Foresters and some sawyers recruited through Army agency arrived by train, which was stopped under Army orders on the open line between two railway stations! The country was absolutely undeveloped with no communication whatsoever, the terrain being undulating and intersected by nullahs and small streams. Under normal trade conditions the crop was not considered sufficiently rich to attract contractors, the forest being of a mixed semi-evergreen type with scattered **Tetrameles nudiflora** in the top canopy and species like **Cyclostemon assamica, Canarium begalense, Stereosperum chelonoides,** etc., with a few valuable species like **Amoora wallichii Artocarpus** chaplasha etc. forming the lower canopy. The incidence of these valuable species was rather low, but there were a few patches of **Terminalia-**

myriocapra and **Phoebe goalparensis** along the river banks. Under the conditions prevailing at the time particularly in regard to food supplies, sickness, and lack of any communication in the area where the camp had to be located, the first problem to be tackled was the supply of food articles, installation of a small dispensary to attend to sickness and establishing a road connection with the base. All these were satisfactorily solved, though after a considerable amount of trouble. A link-road about five miles in length to the BASE was constructed in a record time of about three months between May and July, and arrangements for food supplies by wagon load from the nearest district headquarters was made. But the labour problem was the most difficult, as the local villages had already evacuated from the surrounding areas. Once the link road was established there was some increase in the number of sawyers with a corresponding increase in unskilled labour to make feeder roads for extraction and the camp houses required.

4. The timber demand increased from day to day as the army began to prepare for an offensive, but the number of sawyers proved insufficient. Besides timber had to be produced at short notice and the army required exact sizes which could be utilised directly on the job. A portable saw-mill was therefore installed, with one saw-bench to start with, to supplement whatever sawyers were available. This completed the first phase of the organisation.

5. The timber operations gradually gained in momentum and as the advantages of the saw-mill began to be realised it was decided to expand the same. In those war days of utter confusion it was extremely difficult to get suitable machinery and spare parts for the saw-mill, and these had to be collected from the army, or from the trade, or from scrap-heaps, by exercising personal influence through official and non-official channels It was felt that though the department was responsible for the production of timber it would be unwise to run the mill purely departmentally, as if all day to day expenditure on the mill had to be met as departmental charges, the formalities of getting necessary sanctions etc. would have meant very lengthy procedure and would have hampered progress. The mill was therefore allowed to be owned and run by a contractor, who was paid for sawing-up the timber at a certain agreed rate, less the cost of all oil, lubricants etc., supplied. Logs were collected and delivered to the mill by the department and elephants had to be engaged to drag the logs to the newly constructed feeder roads and Government vehicles (3 ton Ford trucks) had to be purchased for the transport of the logs to the mill site. All this required a large force of unskilled labour, and as it was no longer possible to get the required number of labour locally, and secondly it was not possible to work according to a schedule with the local labour, it was decided to recruit labour from outside. About 100 Orissa labourers, mostly evacuees from Burma, were to start with recruited departmentally and later on a firm was entrusted with the work on a commission basis. (This contract is still running and the labourers work for nine months on conditions that they get railway fares for coming from and going back to their home district i.e. Ganjam, and other concessions such as mosquito-nets, blankets etc). While the work was in full swing a great set-back occurred when the Japanese crossed the Burma border and invaded Assam surrounding Imphal and Kohima, and striking to within 20-25 Miles of Manipur road Base and the railway line to Upper Assam, in 1944. It proved extremely difficult to keep the organisation going under such circumstances, as even half the army organisation moved back, but the forest Staff stuck to their posts and though there was dislocation for a while this was overcome in the end.

6. As the strength of the colony increased mere curative measures for sickness were not considered sufficient. It was considered necessary to carry out regular anti-malarial work and the matter was taken up with the Public Health Department and in course of time draining of the marshy areas, spreading of malariol, and giving prophylactic dose of Mepacrine became routine measures. This produced surprisingly good results and within a year the high percentage of malaria decreased. The following figures will show that anti-malarial work if carried out properly can make any of the usually malarious forest places quite habitable:—

1945	2139	The population of the
1946	1610	camp more or less remained
1947	838	constant.

Prior to this about 95% of the population at Rangapahar used to suffer from malaria while in 1947 not more than 10% got this infection. This completes the second phase of the development.

7. The war came to an end at last. During the war period the demand was mostly for hutting-timber and most of the hardwoods were completely cut out in areas adjoining the roads which had to be opened during the period. The next problem was to utilise this organisation for peace

time work when a different aspect of forestry had to be considered. The soft-wood stocks had remained almost intact during war time, and while there was no local market, an increasing market was to be had in Calcutta for packing-case materials. In prewar days Messrs Bata Shoe Co., had taken some packing case timber from Assam in the log form but the total export to Calcutta was almost negligible, mainly because of the transport difficulties, and the price offered was ridiculously low. Negotiations were opened by the Forest Utilisation Officer with Messrs Bata Shoe Co., for a forward contract for sawn-timber, as it was felt that no sawmill could plan the work without an assured market for their products, and to start with a trial order was obtained. Batas placed this order almost reluctantly as they considered it an impracticable scheme, but it proved to be so satisfactory that they later entered into an agreement to take about 3,500 tons of 1/2" boards per year out of which the Rangapahar mill alone supplied 800—1,000 tons, the balance being met by the other lend-lease mills in the province. While the main cutting is of soft-woods for this supply the local demand for hard-wood timber for building and P. W. D. and constructional work is also met as far as possible. Present equipment is as follows:—

A. Deisel Engines.

(1) Blackstone Engine 14 B.H.P.
(2) Ruston & Hornsby Engine 17 B.H.P.
(3) National Engine 38 B.H.P.

B. Saw Benches:

(1) 3' Diam. Horizontal Band for breaking logs —one
(2) 3' Diam. Vertical Band for breaking logs —one
(3) 36" Circular Saw —one
(4) 28" Circular Saw -three
(5) 28" Diam. Table Band Saw —one
(6) Pendulum Cross Cut Saw —one.

These can produce about 120 tons of timber per month, mostly as 1/2" boards.

8. As the mixed forests of Upper Assam contain large stocks of inferior hard-woods and soft-woods, which normally remain un-utilized in the forests or are sold as firewood, the installation of this and similar sawmills, of which are over a dozen in the valley, has opened up a new prospect of profitable utilisation of such timber. Selection felling provide the greater percentage of the mill requirements, while clear-felling supplements the log supply, and at the same time provides the necessary employment by way of plantations for the large permanent gang of labour stationed at the mill. In this manner replacement of poorly stocked inferior type of forest with concentrated stands of plantations is possible. Within two years a little less than 300 acres of such plantations have been created without any difficulty near this particular mill. The value of this type of operation cannot therefore be over estimated. The retention of a permanent gang of labour makes it possible to attend to all weedings and tending works at the correct moment, while in the cold weather extraction roads can be built, anti-malarial works carried out etc. The rate of wages of this permanent gang are usually higher than the local labour but because of strict supervision and planned working the cost of operations is kept down. Moreover, because of the concentrated working a very large amount of work can be handled by a skeleton staff consisting of a gazetted officer, a ranger and two foresters with some field assistants. Rangapahar, within a short period of years, has been able to build up a gravel road 13 miles in length constructed through deep forest and crossing numerous streams with an additional 25 miles of feeder roads. The working there has given us experience how to run a grocery shop, how to align roads, how to build bridges and how to create plantations and has certainly proved a great training ground for the staff.

9. Experience gained from this organisation is summarised as follows:—

(i) The installation of small semi-portable saw-mills of the type mentioned above ensures the maximum utilisation of every species capable of yielding timber of moderate quality. The low incidence of marketable species in this type of forest will not attract any sawyers for stump-sawing and vast areas would otherwise remain unexploited.

(ii) The consumers get their requirements in exact sizes and are prepared to pay good prices for them and the movement of the sawn products to centres of consumption is easy and less costly than in the log form.

(iii) Concentrated working gives the maximum economy in staff.

(iv) With departmental operations contracts can be fulfilled in proper time and new species can be introduced into the market.

(v) With works of diverse nature concentrated in one place, the maintenance of semi-permanent labour gangs engaged all the year round becomes a feasible proposition. The use of trucks to move labour about and to carry gravel for road making and timber for bridges, as well as the logs to the Mill, is most valuable (very large logs can be broken down by hand-sawing in the forest before transport to the mill).

(vi) When an area is exhausted (as has been found to be the case in the Rangapahar reserve under review in this articles,) the saw-mill can be removed to another reserve, or to a new site, at a reasonable cost. Ordinarily however this should not be necessary for at least 5 years. It is essential however to have a working-scheme prepared for the forests on which such a mill is based.

(vii) Incidence of malaria, which is the greatest handicap in any timber work, can be controlled in such concentrated work-centres at a reasonable cost. It is also possible to give social amenities to such a colony.

(5) Control of Loranthus Pest in Forest Plantations

By H. T. Koppikar
(Range Forest Officer, Hanavar)

G|243|Bo., S|843|Bo.-Loranthus is reported as spreading fast in the plantations of teak and Casuarina; measures adopted to combat the pest and suggested work are described.

Loranthus—infested trees along roads, on and around village—sites and fringes of cultivation are a common enough sight in the peninsular tract of the Indian dominion. Loranthus is fast spreading into forest plantations. This is a bird-borne parasite. Its seeds with the sticky outer layer of pulp are distributed by birds and the seeds germinate and take root on twigs, branches, and crevices of trees. Loranthus sends its haustoria into the wood layer of the host and draws its supply of water and mineral substances. It manufactures its own food by means of photosynthesis.

Honavar range in the western division of the North Kanara district is comprised of semievergreen and evergreen forest. Natural teak is poorly represented in the original stand of this forest; but the conditions of climate, soil and rainfall obtaining here are well suited for artificial regeneration of teak. This range boasts of about 5,000 acres of area under planted teak of which about—2,400 acres constitute the area of older plantations, raised from 1919 to 1928. There are also Casurina plantations roughly 450 acres in extent extending along the Arabian sea-board which are worked on a 20 year rotation. But out of this area under teak and Casurina an area of about 950 acres of teak and over 250 acres of casuring plantation is infested with loranthus to a more or less extent. The younger plantations of these species are not—affected so far, by this pest. A cursory study of the location of the affected plantations brings out the fact that these are situated mostly on sides of old abandoned cultivation, and those—contiguous to palm gardens, village sites and land under the plough with fruit and other trees on their fringe. Loranthus—infestation is no doubt widespread in casurina plantations; but this species being grown for firewood, though the yield of firewood may to a small extent be adversly affected due to this infestation its quality is apprently not. The writer therefore restricts himself to the ravages of this pest in teak plantations.

Much land under cultivation situated inland in forest—areas in North Kanara district was abandoned and villages deserted, some decades back. The responsibility of this expensive abandonment of land and mass exodus is often fathered upon the past forest policy and alleged consequent creeping of forest into is doubtful. Because it is difficult to single out the birds which spread this pest. To destroy all such birds is still more difficult. But above all, it is very likely that mass destruction of birds may disturb Nature's balance of insect life and its predatories; this may result only in rapid multiplication of insects which may affect plantations more adversly than loranthus is likely to do. Wholesale removal of affected trees may not only reduce the forest capital but may bring about overwide and uneven spacing and its consequences and invite aggressive and unwanted growth in the plantations.

As such the writer suggests:—

that (1) in addition to removal of affected branches of trees and of very extensively affected trees, the existing intermediat belt of minor forest, which would prove insular to a considerable—extent, be retained and maintained between cultivation and plantations; and

(2) the urgent need for all-out effort at eradicatng loranthus from cultivations, gardens, orchards and villages be brought home to the notice of the public through co-ordination between Departments of Revenue, Agriculture, Forests and Public works and the Rural Development Board. The spirit of "kill loranthus and save trees" slogan, could be instilled in the public mind with advantage. through the—"workers" and results would not be slow coming.

(6) "A Living – Fossil Tree"

(Metasequoia glyptostroboides Hu et Cheng)

By

M. B. Raizada, Systematic Botanist,
Forest Research Institute, Dehra Dun.

The discovery of **Metasequoia glyptostroboides** in China is a grand and most unexpected surprise for it has rarely happened when a plant originally based on paleobotanic records is found to have a living representative.

Although not quite so ancient, geologically, as the **Ginkgo**, the **Metasequoia** has persisted through many, very many millions of years, for it developed in Mesozoic times, when the animal life of the globe was dominated by the long-extinct **giant reptiles.**

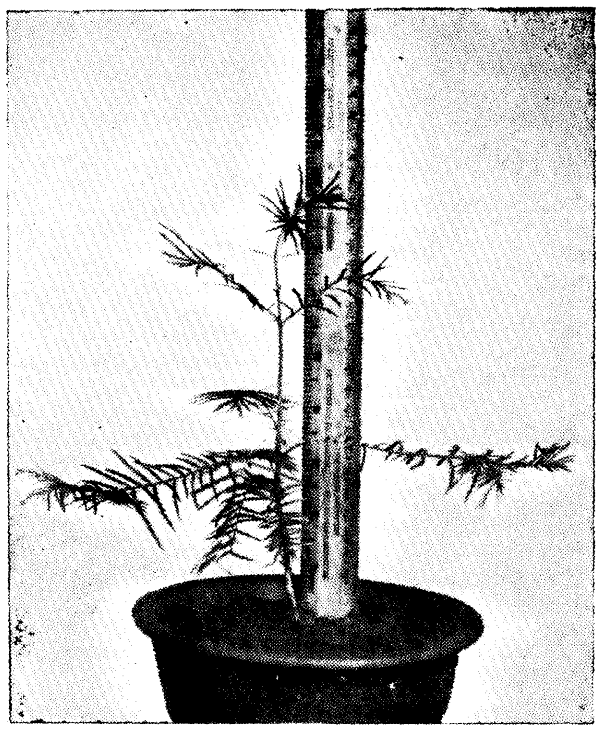
The story of the wonderful 'find' of this **Metasequoia** is now told by Prof. E. D. Merrill in Arnoldia, Vol. 8 pt. I. 1948, from where much of the information contained in this note has been extracted. According to Dr. Merrill the remarkable discovery of this coniferous tree, **Metasequoia glyptostroboides,** was made in 1945 by T. Wang of the Ministry of Agriculture & Forestry, China, who found only three trees in Szechuan Province, South-west China, but he misidentified it as **Glyptostrobus pensilis.** In the following year Prof. Wan-Chun Cheng, of the National Central University, Nanking, sent out another expedition and Mr. C. J. Hsueh, who led the expedition brought the sensus up to about twenty-five trees. When the botanical material reached the Arnold Arboretum, Harvard University, Jamaica Plain, Mass., U.S.A. it aroused so much interest that Dr. E. D. Merrill arranged with Dr. H. H. Hu, Director of the Fan Memorial Instituted of Biology in Peiping, and one of the joint authors concerned with the actual description of the species, to send a third expedition to Szechuan, close to the Hupeh border. Prof. Wan-Chun Cheng organised the expedition, which was led by Mr. Hsueh, who found more than a hundred large trees representing this species, occuring on slopes, along small streams, and near rice paddies, between the altitudes of 900 and 1,300 m. Later at least a thousand trees were located in the Shin-sa-pa valley in Hupeh Province. It is of interest to note that in this valley, where the tree is most abundant, there are no groves or forests made up of this species but the trees occur widely scattered.

The living**Metasequoia** is said to be a large tree, attaining a height of about 115 ft., with a trunk diameter of 7½ ft. Like **Larix** (Larch) and **Taxodium distichum** (Swamp cypress) its leaves are deciduous, the tree being leafless in the winter. Its botanical alliance is hardly with **Sequoia,** as one might infer from the generic name. In the vegetative characters it suggest **Glyptostrobus** and **Taxodium** but it may prove to be not closely allied to these two genera, one of the South-eastern China, the other of North America.

Through the courtesy of Prof. Wan-Chun Cheng a small packet of seed of **Metasequoia** glyptostroboides was received by the author early in February 1948, for propagation in this country. In the forwarding letter, dated the 25th Dec. 1947, Prof. Cheng writes as follows:—

"I beg to inform you that we have recently discovered a living species of the fossil genus, **Metasequoia** of Coniferae. The genus was described by S. Miki in the Japanese Journal of Botany XI. p. 261 (1941). The genus has ten fossil species and one living species. The only living species. **Metasequoia glyptostroboides Hu** et Cheng, is confined to eastern Szechuan and South-western Hupeh in eastern China. This is a big tree 35 m. tall and 2.3 m. in diameter. It is manifestly allied to the American genera **Sequoia** and **Sequoiadendron,** but differs from both in the deciduous habit and in the opposite branchlets, leaves, flowers and cone scales. It seems to be an intermediate link between **Taxodiaceae** and **Cupressaceae.** The mature seeds of the **Metasequoia** were secured this year. Enclosed here I am sending you a few mature seeds of **Metasequoia glyptostroboides** Hu et Cheng for propagating in your country. I think you are interested to have them."

The seeds which were sown on 23.2.48 gave excellent germination results and some of the seedlings are now 9 in. tall and growing vigorously. A photograph of one of the seedlings is here reproduced to show its juvenile habit and foliage, for it is believed that this is the first illustration of a cultivated **Metasequoia** from India. It seems now fairly certain that somewhere in our country it will be possible to establish in cultivation this remarkable ancient coniferous species which in its native country is apparently on the verge of extinction.



A seedling of **Metasequoia glyptostroboids** *Hu et Chens about 5 months old showing juvenile habit and foliage.*

(7) Further Note on Constants Connecting Top Height and Age for Different Site Qualities in Teak Plantations

By M. S. Raghavan, Silviculturist, Madras.

G|632|Md., S|9Md.—The paper puts forth a formula method of determining the equality of a teak plantation of known age and top height. The Statistician of the forest research institute points out the need of exploratory work on actual observed data before establishing the relationship.

In my article on constants connecting top height and age for different site qualities in teak plantations kindly published by the Indian Forester on pages 460 and 461 of Vol. 72, No. 10, for October 1946, an indication was given that the variable constant **a** which varies with the Teak quality class appears to be connected with the number expressing such quality class. This connection has since been worked out by me, and then a general formula applicable to all quality classes, and eliminating logarithms has also been formulated. If **h** is the height in feet at age **a** in years, for All India Yield Table quality class **q**, then

$$h = 4.84\ (8\text{-}q)\ a.\ 3244 \ldots\ldots(C)$$

In practice a Forest Officer may object to the great difficulty of raising the age to such a fractional power. As raising any number to the power 0.3333 amounts to the extraction of the cube root of the number, the above formula has been recalculated to give the approximate but easier formula

$$h = 4.64\ (8\text{-}q)\ \sqrt[3]{a} \ldots\ldots(A)$$

Heights calculated for different ages at five yearly intervals between the ages of 5 and 80 by the formula (c) above is entered under column C for each quality class and age, and similar heights computed by the approximate formula (A) above are similarly entered in the column A under each Quality class, while the heights according to the All India Yield Table are entered under column Y, in the enclosed tabular statement.

It will be seen that the heights by the approximate formula at age 5 are about 14.5 per cent or about one seventh less than the yield table heights, while the heights at age 10 are about 3 percent less. This departure is as mentioned in my previous article probably due to the trees not having settled down to their quality classes at this early age. This is a matter for further investigation, but the phenomenon is well known to Forest Officers who have studied Teak.

The close agreement between the diffenent columns for ages 15 to 80 indicate the acceptability of the formulae. The drawing of the cube root of the age is noticeable. As volume is three dimensional, while height is single dimensioned, age contributes one cube root to the height while the product of the other two cube roots, contributes apprently to the sectional area, or what comes to the same idea the other two cube roots contribute to the two diameters.

As every forest officer knows enough arithmetic to guess easily cube roots of small numbers below 80, to one or two places of decimals, the second formula has practical approximate application in every day life. It may also be remembered that 4.64 is nearly 42/3 .

The approximate formula may be altered to help a forest officer to determine the quality class of a teak plantation by All India standards. Thus

$$\textbf{All India Quality} = 8 - \frac{h}{4.64\ \sqrt[3]{a}}$$

As a test suppose we measure the top height of a teak plantation of age 25, and find it to be 88 ft. Then by applying the formula we find the All India Quality Class

$$q = 8 - \frac{88}{4.64\ \sqrt[3]{25}} = 8 - \frac{88}{4.64x/2.92} = 8 - \frac{88}{13.6} = 8 - 6.5 = 1.5$$

Quality 1.5 should be interpreted as being midway between All India I and All India II Quality, i.e. the quality is a High All India II quality. The actual Yield table height at age 25 for All India High II quality is 90 ft. Considering the errors inherent in Abney measurements, and incidental experimental errors, the result of the quality class determination appears acceptable for all practical purposes.

I am now turning my attention to the connection between Top Height, Quality Class, Age, and Major crop number of stems, to find out an acceptable formula for every day use by Thinning Officers in Teak Plantations, as this is the final practical test of these apprently theoretical determinations. A further contribution on this vital problem will follow in due course.

Satistician, F.R.I.'s comments on the paper "A further note on constants connecting top height and age for different site qualities in teak plantations" by Mr. M. S. Raghavan, Silviculturist, Madras.

Mr. Raghavan's paper shows that the freehand smooth curves drawn by Laurie & Bakshi Sant Ram to find the relationship between top height and age of teak for different quality classes will on a logarithmic scale for both height and age, reduce almost to straight lines, except at the earlier ages 5 and 10 years. The goodness of fit of the formula (C) or (A) should be tested on the original observations of top height and age on which Laurie and Sant Ram's curves are based. By using method of least squares on the original data, the constant 4.84 and .3244 in formula (C), may be found to be not the most probable.

Arguments like "As volume is three dimensional, while height is single dimensioned, age contributes on cube root to the height, while the product of the other two cube roots, contributes apprently to the sectional area, or what comes to the same idea the other two cubes roots contribute to the two diameters" by which the author tries to justify the formula (A) are too speculative and seem to suggest that the 'cube root of age' formula can be applied to all species and not to teak alone.

Two explanations are given by the author for the disagreement between his formula and Laurie & Sant Ram's tabulated values of height at ages 5 and 10. Of these, the first is not true as the curves represented by both the formula (C) and (A) pass through the origin ($h=0$, $a=0$)

The paper is useful in the sense that it points to the possiblity of establishing a mathematically simple relationship between top height and age which can be determined objectively by least square method of curve fitting. Exploratory work on actual observed material is necessary before such a relationship can be said to exist.

STATISTICIAN,
Forest Research Institute.

THE FLORA OF THE KAREWA SERIES OF KASHMIR AND ITS PHYTOGEOGRAPHICAL AFFINITIES WITH CHAPTERS ON THE METHOD USED IN IDENTIFICATION (CONTINUED)

By Dr. G. S. PURI

FLORA OF THE DIFFERENT LOCALITIES

Although some of the species are found to occur in two or more than two, localities, there is a good deal of difference in the general aspect of the flora of three main localities, namely, Laredura, Ningal Nullah and Liddarmarg. The floras of Laredura, Dangarpur and Gogajipathri are very similar to one another in specific aspect; however, a few distinct species, which do not alter the general ecological picture of the particular flora have also been recognised from Dangarpur and Gogajipathri.

The genus **Quercus** is represented in four out of five main localities though the species discovered from Laredura, Dangarpur and Gogajipathri are different from those that are recognised from Botapathri and Liddarmarg. The other well represented genus is **Trapa,** which being a water plant, cannot be used rigidly in emphasising too close a similarity between the flora of the different localities, which as we know, were deposited in a common body of fresh water.

The following table gives a detailed distribution of the species in the fossiliferous localities:

TABLE I.

C—Calculated heights by correct formula h = 4.84 (8-q) age.3244.
Y—Heights according to the All India Teak Yield Tables. (Top heights).
A—Calculated heights by approximate formula h = 4.64 (8-q) x cube root of age.

Quality	High I			Mean I			High II			Mean II			High III			Mean III			High IV			Mean IV			High V			Mean V			Low V		
Age	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A	C	Y	A
5*	61.21	51	59.50	57.13	47	55.53	53.04	43	51.57	48.97	40	47.60	44.88	37	43.63	40.80	33	39.67	36.72	30	35.70	32.64	27	31.73	28.56	23	27.77	.24.08	20	23.80	20.40	17	19.83
10*	76.62	73	74.97	71.52	68	69.97	66.41	63	64.98	61.30	58	59.98	56.19	53	54.98	51.09	49	49.98	45.98	44	44.98	40.87	39	39.99	35.76	34	34.99	.30.65	29	29.99	25.54	24	24.99
15	87.37	87	85.82	81.55	80	80.10	75.72	75	74.38	69.90	69	68.66	64.07	64	62.94	58.25	58	57.22	52.42	52	51.49	46.60	46	45.77	40.77	40	40.05	.34.95	35	34.33	29.12	29	28.61
20	95.90	96	94.46	89.51	90	88.16	83.12	83	81.87	76.72	77	75.57	70.33	70	69.27	63.94	64	62.97	57.54	58	56.68	51.15	51	50.38	44.76	45	44.08	.38.36	38	37.78	31.97	32	31.49
25	103.13	104	101.75	96.25	97	94.97	89.38	90	88.19	82.50	83	81.40	75.63	76	74.62	68.75	69	67.84	61.87	62	61.05	55.00	55	54.27	48.13	48	47.49	.41.25	42	40.70	34.38	35	33.92
30	109.40	110	108.13	102.11	103	100.92	94.82	96	93.11	87.53	88	86.50	80.23	81	79.30	72.94	73	72.09	65.64	66	64.88	58.35	59	57.67	51.06	51	50.48	.43.76	44	43.25	36.47	37	36.04
35	115.03	116	113.83	107.37	108	106.24	99.70	101	98.65	92.03	93	91.06	84.36	85	83.48	76.69	77	75.89	69.02	70	68.30	61.35	62	60.71	53.68	54	53.12	.46.01	46	45.53	38.34	39	37.94
40	120.12	121	119.01	112.11	113	111.08	104.10	105	103.14	96.09	97	95.21	88.09	89	87.28	80.08	81	79.34	72.07	73	71.40	64.06	64	63.47	56.05	56	55.54	.48.05	48	47.60	40.04	40	39.67
45	124.80	126	123.78	116.48	118	115.52	108.16	109	107.27	99.84	101	99.02	91.52	92	90.77	83.20	84	82.52	74.88	75	74.27	66.56	67	66.01	58.24	58	57.76	.49.92	50	49.51	41.60	42	41.26
50	129.16	130	128.20	120.55	121	119.66	111.93	113	111.11	103.32	104	103.56	94.71	95	94.02	86.10	87	85.47	77.49	78	76.92	68.88	69	68.38	60.27	60	59.83	.51.66	52	51.28	43.05	43	42.73
55	133.18	134	132.34	124.31	125	123.52	115.43	116	114.70	106.55	107	105.87	97.87	98	97.05	88.79	89	88.23	79.91	80	79.40	71.03	71	70.58	62.15	62	61.76	.53.27	53	52.94	44.39	45	44.11
60	137.00	137	136.24	127.86	128	127.15	118.73	119	118.07	109.60	110	108.99	100.46	101	99.91	91.33	91	90.82	82.20	20	81.74	73.06	73	72.66	63.93	64	63.58	.54.80	55	54.49	45.67	46	45.41
65	140.63	141	139.92	131.25	131	130.59	121.88	122	121.26	112.50	112	111.94	103.13	103	102.61	93.75	94	93.28	84.38	85	83.95	75.00	75	74.62	65.63	66	65.30	.56.25	56	55.97	46.88	47	46.64
70	144.07	144	143.42	134.47	134	133.86	124.86	125	124.30	115.26	115	114.73	105.65	106	105.17	96.05	96	95.61	86.44	86	86.05	76.84	77	76.49	67.23	67	66.93	.57.63	58	57.37	48.02	48	47.80
75	147.31	147	146.76	137.49	137	136.97	127.66	128	127.19	117.84	118	117.40	108.02	108	107.62	98.20	98	97.84	88.38	88	88.05	78.56	78	78.27	68.74	69	68.48	.58.92	59	58.70	49.10	49	48.91
80	150.42	150	149.95	140.40	140	139.95	130.37	130	129.95	120.34	120	119.96	110.13	110	109.96	100.28	100	99.96	90.26	90	89.96	80.22	80	79.97	70.20	70	69.97	.60.17	60	59.98	50.14	50	49.98

* At age 5, the Yield Table height is one seventh or 14.5 percent less than the height by the approximate formula; and at age 10 Yield table height is about 3% less than the height by the approximate formula. This is to be expected, firstly as regression curves rarely passthrough the origin; and also as is well known, Teak trees do not usually reflect their quality classes in the first ten years of their life.

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COMPOSITION OF THE FLORA

The Karewa flora is composed of 122 species of angiosperms, 6 species of gymnosperms and one species of Pteridophyta discovered from 22 different localities, which are not only separated from one another by a distance that ranges from one to forty miles in some cases but the beds are also situated at different altitudes.

A glance at table I reveals that there is a great deal of differences in species between the floras of the different localities. Excepting some water plants and a few terrestrial species, the number of which is given in the following table, which are common to two or three localities, most of the species from one locality are distinct from the others. The differences are so well marked and striking that an analysis of the floras according to locality seems necessary. The following table is intended to bring out the total number of the species in one locality and the number of those which are common to the other localities:—

Locality	Total No. of species.	No. of species common to two or more localities.		Localities to which the species are common.
1. Laredura	35	8	(3*	Dangarpur, Nagbal, & Gogajipathri.
			(3	Liddarmarg.
			(1	Ningal Nullah.
			(1	Dangarpur.
2. Ningal Nullah	39	6	(4	Laredura.
			(	Liddarmarg.
3. Dangarpur	18	4	(3*	Laredura, Nagbal & Gogajipathri.
			(1	Laredura.
4. Nagbal	8	3*		Laredura, Dangarpur & Gogajipathri.
5. Liddarmarg	33	5	(3	Laredura.
			(2	Ningal Nullah.
6. Gogajipathri	11	3*		Laredura, Dangarpur, Nagbal.
7. Botapathri	4	4		Liddarmarg.

Note:—1) In this table water plants are not included, because most of the aquatic species are common to all the localities and their inclusion may have brought out too close a similarity, which is not real.

2) The figures marked with an asteriks indicate the number of common species. *The three common species at* Laredura, Dangarpur, *Nagbal and Gogajipathri are* **Quercus semecarpifolia, Q. dilatata and Q. Ilex.**

Species	Laredura							Dangarpur					Nag-bal.	Ningal Nullah				Botapathri		Gogaji-pathri	Liddar marg.	
	Puri Loc.						De Terra Loc.	Puri Loc.		De Terra Loc.	Sahni Loc.		Nagbal.	Stewart Loc.	Puri Loc.			Sarup Loc.	Shani Loc.	Gogajipathri	Middlemiss Loc.	De Terra Loc.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alnus nepalensis														x							x	x
Alnus nitida		x	x																			
Carpinus faginea							x															
Carpinus viminea			x																			
Corylus ferox			x																			
Quercus semecarpifolia	x	x	x	x	x		x	x	x	x	x	x	x							x		
Quercus dilatata	x	x	x	x	x		x	x	x	x	x	x	x							x		
Quercus Ilex	x	x	x	x	x		x	x	x	x	x	x	x							x		
Quercus glauca																	x	x				x
Quercus incana																	x	x				x
Ulmus Wallichiana							x															
Ulmus laevigata							x							x								
Ulmus campestris			x																	x		
Ficus Cunia																					x	x
Elaeodendron glaucum																						x
Rhamnus virgata																						x
Rhamnus purpurea														x								
Berchemia floribunda																						x
Sageretia oppositifolia														x								
Leea aspera																						x
Skimmia Laureola																						x
Toddalia aculeata (?)																					x	
Aesculus indica		x		x										x		x	x					
Acer oblongum																					x	x
Acer pentapomicum														x		x	x					
Acer pictum	x															x						
Acer Caesium							x								x	x	x					
Acer villosum															x	x	x					
Acer sp. A	x																					
Acer sp. B	x																					

Acer sp. C.													x				
Rhus punjabensis							x										
Rhus Cotinus																	x
Rhus succedanea							x										
Lannea grandis							x										
Juglans regia											x		x	x			
Engelhardtia colebrookeana																	
Cornus capitata																	
Cornus macrophylla													x				
Marlea chinensis											x		x	x			
Hedera nepalensis	x		x				x	x									
Myrsine semiserrata																	x
Myrsine africana	x																
Fraxinus excelsior							x										
Fraxinus xanthoxyloides							x										
Syringa Emodi																	
Olea glandulifera	x																x
Hamiltonia suaveolens								x									
Randia tetrasperma																	x
Wendlandia exserta																	x
Viburnum cotinifolium							x										
Viburnum stellulatum											x						
Lonicera quinquelocularis							x										
Leycesteria formosa (?)											x						
Inula cappa												x	x				
Typha sp.		x		x		x	x	x	x	x	x			x	x	x	
Sparganium sp.		x		x		x	x	x	x	x	x			x	x	x	x
Pinus longifolia			x				x										x
Pinus excelsa	x		x	x	x		x										
Abies Webbiana	x		x	x	x		x										
Cedrus Deodara	x		x	x	x		x										
Picea Smithiana	x		x	x	x		x										
Machilus odoratissima																x	x
Machilus Duthiei																x	x
Phoebe lanceolata																x	
Litsea lanuginosa																x	
Litsea elongata								x							x	x	x
Ranunculus sp.							x										
Clematis sp.							x										
Ceratophyllum sp.							x	x		x							
Nelumbo nucifera											x						
Berberis ceratophylla							x										x
Berberis sp. A																x	
Berberis sp. B													x				

Species	Laredura							Dangarpur					Nag-bal	Ningal Nullah				Botapathri		Gogaji-pathrî	Liddar-marg	
	Puri Loc						De Terra Loc.	Puri Loc.		De Terra Loc.	Sahni Loc.		Nagbal.	Stewart Loc.	Author's Loc.			Sarup Loc.	Shani Loc.	Gogajipathri	Middlemiss Loc.	De Terra Loc.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Berberis sp. C																						x
Woodfordia fruticosa	x																					
Trapa natans						x			x	x	x	x	x					x	x	x	x	x
Trapa bispinosa						x			x	x	x	x	x					x	x	x	x	x
Myriophyllum sp.							x			x				x								
Pittosporum eriocarpum																					x	
Mallotus phillippinensis				x			x															x
Prunus cerasoides							x															
Pyrus Malus														x		x	x					
Pyrus communis																						x
Pyrus lanata																				x		
Pyrus Pashia	x														x							
Pyrus sp.														x								
Rosa Webbiana							x													x		
Rosa macrophylla							x															
Cotoneaster bacillaris							x															x
Cotoneaster microphylla														x		x						
Cotoneaster nummularia														x			x					
Cotoneaster sp.														x		x	x					
Rubus fruticosus				x	x	x																
Rubus sp. A	x																					
Rubus sp. B	x																					
Spiraeae sp. A																					x	
Spiraeae sp. B	x																					
Desmodium podocarpum																						x
Desmodium laxiflorum																						x
Desmodium tiliaefolium							x															
Desmodium latifolium							x															
Desmodium gangeticum														x								
Desmodium nutans							x															

Desmodium sp.							
Indigofera hebepetala		x					
Indigofera sp.		x					
Parrotia jacquemontiana							
Buxus papillosa							x
Buxus Wallichiana							x
Salix Wallichiana			x	x		x	
Salix denticulata		x	x				
Salix tetrasperma (?)			x	x			
Salix acmophylla (?)				x	x	x	
Salix viminalis (?)	x			x		x	
Salix sp.	x						
Populus ciliata			x		x		
Populus nigra			x	x	x	x	
Populus sp. A			x				
Populus sp. B			x				
Betula utilis		x	x		x		
Batula alnoides			x				
Betula sp.			x				

Below is given a list of the species identified from each locality. The species marked with asteriks (*) in the following lists are common to one or the other locality.

LIST OF SPECIES IDENTIFIED FROM LAREDURA:

Altitude 6,000 to 6,500 ft. above sea level.

Ranunculus sp.
Clematis sp.
***Ceratophyllum** sp.
***Berberis ceratophylla G. Don.**
***Trapa bispinosa** Roxb.
***Trapa natans** L.
***Myriophyllym** sp.
Prunus cerasoides D. Don.
Rosa Webbiana Wall.
Rosa macrophylla Wall.
Cotoneaster bacillaris Wall.
Pyrus pashia Buch—Ham.
Rubus fruticosus Linn.
Rubus sp. A.
Rubus sp. B.
Spiraea sp. B.
Desmodium tiliaefolium G. Don.
Desmodium latifolium D.C.
Desmodium nutans Wall.
Indigofera hebepetala Benth.
Indigofera sp.
Salix denticulata Anders.
Salix acmophylla Boiss.
Salix viminalis Linn.
Betula utilis D. Don.
B. alnoides Buch—Ham.
Alnus nitida Endl.
Carpinus faginea Lindl.
Carpinus viminea Lindl.
Corylus ferox Wall.
Quercus semecarpifolia Smith.
Quercus dilatata Lindl.
Quercus Ilex L.
Ulmus Wallichiana Planch.
Ulmus laevigata Royle.
Aesculus indica Colebr.
Acer pictum Thunb.
Acer Caesium Wall.
Acer sp. A.
Acer sp. B.
Rhus succedanea Linn.
Rhus punjabensis Linn.
Lannea Woodier Roxb.
Engelhardtia colebrookiana Lindl.
Hedera nepalensis K. Koch.
Myrsine africana Linn.
Fraxinus excelsior L.
Fraxinus xanthoxyloides Wall.
Olea glandulifera Wall.
Viburnum cotinifolium D. Don.
Lonicera quinquelocularis Hardw.
Typha sp.
Sparganium sp.
Pinus
Cedrus
Abies
Picea

The Laredura flora is composed of 55 species distributed in 35 genera and 22 families. Quantitatively the best represented genera are **Quercus** with three species and **Trapa** with two species. Both are represented by several hundred specimens, the former by leaves and the latter by fruits. Other well represented genera ane **Acer** with 4 species, **Rubus, Desmodium,** and **Salix** with three species each, and **Rosa, Carpinus,** Ulmus and **Fraxinus** have got 2 species each. The aquatic element is composed of 6 species belonging to 5 genera.

LIST OF SPECIES FROM NINGAL NULLAH

Altitude 9,000 to 9,800 ft., above sea level.

Nelumbo nucifera Gaertn.
Pyrus Malus L.
Pyrus sp.
Cotoneaster microphylla Wall.
Cotoneaster nummularia Fisch.
Cotoneaster sp.
Desmodium gangeticum D.C.
Salix Wallichiana Anders.
Salix denticulata Anders.
Salix sp. A.
Salix sp. B.
Populus ciliata Wall.
Populus nigra Linn.
Populus sp. A.
Populus sp. B.
Betula alnoides Buch-Ham.
Betula sp. A.
***Alnus nepalensis** D. Don.
Ulmus laevigata Royle.
Elaeodendron glaucum Pers.
Rhamnus purpurea Edgew.
Sageretia oppositifolia Brong.
***Aesculus indica** Colebr.
Acer pentapomicum J. L. S.
Acer pictum Thunb.
Acer villosum Wall.
Acer sp. E.
Juglans regia L.
Cornus macrophylla Wall.
Marlea chinensis Lour.
Viburnum stellulatum Wall.
Leycesteria formosa Wall.

Inula cappa
***Typha** sp.
***Sparganium** sp.

The three species of **Quercus**, which form a major part of the collections in the first locality (Laredura) are conspicuously absent from these beds. The absence of **Quercus** from this locality is interesting as it gives a different aspect to this flora, the dominant genera of which are **Salix** with 4 species, **Populus** with 4 species, **Acer** with 4 species, **Cotoneaster** with 3 species and **Alnus, Viburnum** with two species each. This flora is composed of temperate genera, namely, **Salix, Populus, Pyrus, Acer, Juglans, Rhamnus, Aesculus, Alnus** and **Viburnum** and most of the species do not occur in the floras of other localities.

LIST OF SPECIES FROM DANGARPUR

Altitude 6,500 ft. above sea level.

***Ceratophyllum** sp.
***Trapa natans** L.
***Trapa bispinosa** Roxb.
Myriophyllum sp.
***Quercus semecarpifolia** Smith.
***Quercus dilatata** Lindl.
***Quercus Ilex** L.
Rhus cotinus
Hedera nepalensis K. Koch.
Hamiltonia suaveolens Roxb.
***Typha sp.**
***Sparganium** sp.

The two genera **Quercus** and **Trapa** are dominant in this flora. Excepting two species, namely, **Rhus Cotinus**, Linn. and **Hamiltonia suaveolens Roxb.**, the rest of the plants are common with Laredura.

LIST OF SPECIES FROM NAGBAL

Altitude approximately 6,500 ft. above sea level.

* ?**Ceratophyllum** sp.
***Trapa natans** L.
***Trapa bispinosa** Roxb.
***Quercus semecarpifolia** Smith.
***Quercus dilatata** Lindl.
***Quercus Ilex** L.
***Typha** sp.
***Sparganium** sp.

Quantitatively **Trapa** and **Quercus** are the dominant genera. All the species composing this flora have also been found from Dangarpur and Laredura.

LIST OF SPECIES FROM LIDDARMARG

Altitude 10,600 ft. above sea level.

Machilus odoratissima Nees.
Machilus Duthiei King.
Phoebe lanceolata Nees.
Litsaea lanuginosa Nees.
Berberis ceratophylla G. Don.
Pittosporum eriocarpum Royle.
Mallotus philippinensis Muell.
Pyrus communis L.
Cotoneaster bacillaris Wall.
Spiraea sp. A.
Desmodium podocarpum D. C.
Desmodium laxiflorum D.C.
Desmodium sp.
Parrotia jacuemontiana Dcne.
Buxus papillosa C. K. Schn.
Buxus Wallichiana Baillon.
***Alnus nepalensis** D. Don.
***Quercus glauca** Thunb.
***Quercus incana** Roxb.
Ficus Cunia Buch-Ham.
Rhamnus virgatua Roxb.
Berchemia floribunda Wall.
Leea aspera Wall.
Skimmia Laureola Sieb., et Zucc.
Toddalia aculeata Pers.
Acer oblongum Wall.
***Acer pentapomicum** J. L. S.
Cornus capitata Wall.
Myrsine semiserrata Wall.
Syringa Emodi Wall.
Randia tetrasperma Benth.
Wendlandia exserta D.C.
***Typha** sp.
***Sparganium** sp.

The flora of this locality is essentially different in specific composition from those of the two localities Laredura and Ningal Nullah. Although **Quercus** is fairly well represented in this flora the species are different from those found at Laredura. Another well represented family is Lauraceae, which includes 4 species distributed in 3 genera. A few other genera namely **Pittosporum, Parrotia, Buxus, Ficus, Berchemia, Leea, Skimmia, Toddalia, Syringa, Randia,** and **Wendlandia,** do not occur in any other locality. The flora as a whole is very different from either of the floras discovered from Laredura or Ningal Nullah.

LIST OF SPECIES FROM GOGAJIPATHRI

Altitude 8,800 ft. above sea level.

Litsaea elongata Wall.
***Trapa natans** L.
Pyrus lanata D. Don.
***Quercus semecarpifolia** Smith.
***Quercus dilatata** Lindl.
***Quercus** Ilex L.
Ulmus campestris Linn.
***Typha** sp.
***Sparganium** sp.

The dominant genus in this flora also is **Quercus;** the species do not resemble Liddarmarg, but they are the same as discovered from Laredura and Dangarpur. All species except three, namely, **Litsaea elongata, Pyrus lanata** and **Ulmus campestris** are common with the Laredura and Dangarpur species.

LIST OF SPECIES FROM BOTAPATHRI

Altitude 9,500 ft. above sea level.

***Trapa bispinosa** Roxb.
***Trapa natans** L.
***Quercus glauca** Thunb.
***Quercus incana** Roxb.

Fifty per cent of species from this locality are common with Liddarmarg and the rest with Laredura, Nagbal, Dangarpur and Gogajipathri.

The occurrence of **Quercus** at this place is particularly interesting because all Ningal Nullah localities have yielded a different kind of flora. In the colour of clay and the nature of bedding this locality seems to show a very great resemblance to Liddarmarg.

There is such a close similarity in specific composition between the floras of some of the localities that it seems desirable to group them into three main types; thus, the Laredura flora will include, besides, the Laredura species, some new species from Dangarpur, Nagbal and Gogajipathri; the second will be named as Ningal Nullah flora with distinct species from this locality and the third type, namely, Liddarmarg flora is composed of Botapathri species in addition to its own.

The relative number and percentage of species in the three floras is given as follows:—

Flora	Number of species	Percent of the total
Laredura	57	43.84
Ningal Nullah	39	30.00
Liddarmarg	34	26.16
TOTAL	130	100.00

QUALITATIVE ANALYSIS OF THE FLORA

The Pleistocene flora of the Lower Karewa formations of Kashmir is a heterogenous assemblage of terrestrial herbs, undershrubs, shrubs, trees; and water plants. This paper includes the study of macroscopic remains of the collections; the great wealth of the microscopic remains, which embrace a large number of pollen grains, a large number of diatoms and cuticles are not yet tackled by the author.

The present paper describes 122 different species of Angiosperms, Gymnosperms and Pteridophyta; the species are based on leaves, flowers, fruits, cones, seeds and pieces of bark. A great majority of the species belong to Angiosperms, which are mostly represented by leaves, however, several hundred fruits of two species of **Trapa,** about half a dozen samaras of **Acer** and about the same number of **Fraxinus,** a few female cones of **Alnus** and **Betula,** two oak cupules, two fruits of **Hedera Helix.** L. (in counterparts), an achenial fruit of **Ranunculus** a hairy styled achene of **Clematis,** a rosaceous flower and four pieces of **Betula** bark are also present. The species of **Ranunculus** and **Clematis,** which are unrepresented by foliage are based only on fruits. The two species of **Trapa** are also based on fruits. The two cupules of **Quercus,** one of which was discovered at Laredura and the other at Liddarmarg, could not be specifically determined. The Laredura nut may belong to one of the three species, namely, **Quercus Ilex** L. **Quercus dilatata** Lindl., and **Quercus semecarpifolia** Smith, the leaves of which occur in hundreds among the collections from this place. The Liddarmarg cupule occurred in association with leaves of **Quercus incana** Roxb., and **Quercuc glauca** Thunb; in fact, it was partially overlying a leaf of **Quercus incana** and it may probably belong to one of these two species. The relative paucity of oak nuts as compared to the overwhelming abundance of leaves is striking.

The collections contain quite a few samaras of **Acer,** which consist of either a part of a wing or one half of a double samara. The extreme rarity of double samaras may be explained by the fact that the two connate nuts in a samara split open in dispersal and one is not likely to find a complete specimen. One samara represents a distinct species and specific identification in other specimens is not attempted; they are determined only generically.

The samaras of **Fraxinus** are assigned to two different species. In these species the leaves are rarely represented.

The female cones of alder and **Betula** could not be specifically determined. Fossil leaves of the two modern species of **Alnus** and **Betula** are also found among the same collections in which the cones occur.

Both **Ranunculus** sp. and **Clematis** sp. are based on achenes. The leaves of these two genera being herbaceous are not likely to be represented as fossils.

The bark specimens belong more probably to **Betula utilis** D. Don.

Out of a total of 122 species recognised among the material 117 belong to Angiosperms. These, excepting two species assigned to an aquatic family of Monocotyledons, are all Dicotyledonous trees, shrubs, undershrubs or herbs. On the basis of habit the Angiospermic species are divided into four different elements, namely, trees, shrubs, undershrubs and herbs; the numerical strength and total percentage of each is brought out in the following table:

Element	No. of the Species	Percentage from the total
Trees	59	50.45
Shrubs	43	36.74
Undershrubs	9	7.69
Herbs	6	5.12
	117	100,00

The following are the trees:—

1. **Machilus odoratissima** Nees.
2. **Machilus Duthiei** King.
3. **Phoebe lanceolata** Nees.
4. **Litsaea lanuginosa** Nees.
5. **Litsaea elongata** Wall.
6. **Pittosporum eriocarpum** Royle.
7. **Mallotus philippinensis Muell.** (Small).
8. **Prunus cerasoides** D. Don (Moderate)
9. **Prunus cornuta** Wall. (Medium)
10. **Pyrus Malus** L. (Small)
11. **Pyrus communis** L. (Small)
12. **Pyrus lanata** D. Don., (Small)
13. **Pyrus pashia** Buch-Ham., (Small)
14. **Buxus Walliachiana** Baillon, (Small)
15. **Salix tetrasperma** Roxb., (Medium)
16. **Salix acmophylla** Boiss., (Small)
17. **Populus ciliata** Wall., (large)
18. **Populus nigra** L., (large).
19. **Populus** sp. A.
20. **Populus** sp. B.
21. **Betula utilis** D. Don. (Small).
22. **Betula alnoides** Buch-Ham., (Small).
23. **Betula** sp.
24. **Alnus nepalensis** D. Don., (large).
25. **Alnus nitida** Endl. (large)
26. **Carpinus faginea** Lindl., (Medium),
27. *Carpinus viminea* Lindl., (Medium).
28. **Corylus ferox** Wall., (Medium)
29. **Quercus semecarpifolia** Smith., (large)
30. **Quercus dilatata.** Lindl., (large).
31. **Quercus Ilex** L., (Small)
32. **Quercus incana** Roxb., (Medium)
33. **Quercus glauca** Thunb., (Small or medium)
34. **Ulmus Wallichiana** Planch., (large)
35. **Ulmus laevigata** Royle., (medium or large).
36. **Ulmus campestris** Linn., (small).
37. **Ficus Cunia Buch-Ham.** (Small or medium)
38. **Elaeodendron glaucum** Pers., (Small)
39. **Aesculus indica** Colebr., (large).
40. **Viburnum continifolium** D. Don. (large).
41. **Acer pentapomicum.** J.L.S. (Small or medium)
42. **Acer pictum** Thunb., (large to medium)
43. **Acer Caesium** Wall., (deciduous).
44. **Acer villosum** Wall., (large).
45. **Acer** sp. A.
46. **Acer** sp. B.
47. **Acer** sp. C.
48. **Rhus punjabensis** J.L. Stewart, (small or medium)
49. **Rhus succedanea** Linn., (medium)
50. **Lannea grandis** Engl., (small or medium).
51. **Juglans regia** Linn., (large)
52. **Engelhardtia Colebrookeana** Lindl. (Small).
53. **Cornus Capitata** Wall., (Small)
54. **Cornus macrophylla** Wall., (medium).
55. **Marlea chinensis** Lour., (Small).
56. **Hedera nepalensis K. Koch.,**
57. **Fraxinus excelsior** Linn., (large)
58. **Olea glandulifera** Wall. (Small or medium).
59. **Wendlandia exserta** D.C. (Small)

The following are the shrubs:—

1. **Clematis** sp.
2. **Berberis ceratophylla** Royle., (small).
3. **Berberis** sp. A.
4. **Berberis** sp. B.
5. **Berberis** sp. C.
6. **Rosa Webbiana** Wall., (small).
7. **Rosa macrophylla** Wall. (small).
8. **Cotoneaster bacillaris** Wall., (large).
9. **Cotoneaster microphylla** Wall., (low or prostrate).
10. **Cotoneaster nummularia** Fisch. et Mey. (prostrate).
11. **Cotoneaster** sp.
12. **Rubus fruticosus** Linn., (large).
13. **Rubus** sp. A.
14. **Rubus** sp. B.
15. **Spiraea** sp. A.
16. **Spiraea** sp. B.

17. **Desmodium tiliaefolium** G. Don. (large).
18. **Desmodium nutans** Wall. (large).
19. **Indigofera hebepetala** Benth. (large).
20. **Indigofera** sp.
21. **Parrotia Jacquemontiana** Dcne., (large).
22. **Buxus papillosa.** C.K. Schn., (large).
23. **Salix Wallichiana** Anders., (large).
24. **Salix denticulata** Anders., (large).
25. **Salix viminalis** Linn., (large).
26. **Salix** sp.
27. **Rhamnus virgata** Roxb., (large).
28. **Rhamnus purpurea** Edgew., (large).
29. **Berchemia floribunda** Wall. (large).
30. **Sageretia oppositifolia** Brongn. (large).
31. **Skimmia Laureola** Sieb. et Zucc. (large).
32. **Toddalia aculeata** Pers.
33. **Rhus Cotinus** Linn. (large).
34. **Myrsine semiserrata** Wall., (large).
35. **Myrsine africana** Linn., (smalll).
36. **Fraxinus xanthoxyloides** Wall. (large).
37. **Syringa Emodi** Wall. (large).
38. **Hamiltonia suaveolens** Roxb.
39. **Randia tetrasperma** Benth., (small).
40. **Vibrnum cotinifolium** D. Don. (large).
41. **Viburnum stellulatum** Wall. (large).
42. **Lonicera quinquelocularis** Harew. (large).
43. **Inula cappa.** D.C. (small).

The following are the undershrubs:—

1. **Desmodium laxiflorum** D.C.
2. **Desmodium podocarpum** D.C.
3. **Desmodium gangeticum** D.C.
4. **Desmodium latifolium** D.C.
5. **Desmodium** sp.
6. **Leea aspera** Wall.
7. **Leycesteria formosa** Wall
8. **Typha** sp.
9. **Sparganium** sp.

The following are the herbs:—

1. **Ranunculus** sp.
2. **Trapa natans** L.
3. **Trapa bispinosa** Roxb.
4. **Myriophyllum** sp.
5. **Ceratophyllum** sp.
6. **Nelumbo nucifera** Gaertn.

A glance at the above lists will show that the representation of herbaceous element in the fossil flora is very meagre.

Our 117 species of Angiosperms belong to 59 well determinded genera distributed in 35 families and 22 orders The monocotyledonous element is composed of only two species belonging to two genera and a single family. The dicotyledons include both Achichlamydeae and Metachlamydeae.

The following table, which is intended to bring out the relative representation of the two subdivisions, shows that the Archichlaymdeae are much better represented than the Metachlamydeae.

DIVISION	Orders		Families		Genera		Species	
	No.	%	No.	%	No.	%	No.	%
Archichlamydeae	17	77.28	27	79.42	43	75.44	97	84.61
Metachlamydeae	5	22.72	7	20.58	14	24 56	18	15.39
Total	22	100.00	34	100.00	57	100.00	115	10.000

Taking the number of species as a criterion of dominance the Karewa families fall in the following order:—

Rosaceae with 17 species; Salicaceae and Aceraceae with 10 each; Papilionaceae with 9; Fagaceae, Betulaceae and Lauraceae with 5 each; Berberidaceae, Rhamnaceae, Anacardiaceae, Oleaceae and Caprifoliaceae with 4 each; Rubiaceae, Cornaceae, Urticaceae and Corylaceae with 3 each; Ranunculaceae, Onagraceae, Buxaceae, Rutaceae, Juglandaceae and Myrsinaceae with 2 each; all the rest have one species each.

The best represented genera are **Desmodium** and **Acer** with 7 species each; **Salix** with 6; **Pyrus,** and **Quercus** with 5 each; **Berberis, Cotoneaster,** and **Populus** with 4 each; **Rubus, Betula, Ulmus** and **Rhus** with 3 each; **Machilus, Trapa, Rosa, Spiraea, Indigofera, Buxus, Alnus, Carpinus, Rhamnus, Cornus, Myrsine, Fraxinus** and **Viburnum** with 2 each; the rest of the genera have only one species each.

The Gymnosperms are represented by half a dozen species belonging to the family Coniferales; they are mostly represented by pollen grains or winged seeds but a few leaf fragments are also present. The number of specimens belonging to each species is indeed very small but the family occupies an important position in the Karewa flora qualitatively, as almost all the mo-

dern Himalayan conifers are represented as fossils. Wodehouse's (see Wodehouse and De Terra, 1935) pollen study of the Karewa clays reveals that quantitative representation of the conifer species in the fossil flora was by no means small and with further work on Karewa microfossils the pollen flora is certain to reveal a much larger number of genera and species.

The only Pteridophyta in the collections are ferns, which are represented by two sterile leaf fragments.

The Thallophyta are represented by a great variety of fresh-water diatoms.

QUANTITATIVE ANALYSIS OF THE FLORA

Quantitatively the best represented family is the Fagaceae and the genus **Quercus** possesses the largest number of specimens. It is the most widely distributed genus in the Karewa localities; the other equally well represented genus being **Trapa.** Other terrestrial genera, which are also fairly well represented in the flora, are **Aesculus, Machilus, Populus, Salix, Acer, Contoneaster Rhamnus, Desmodium** and **Ulmus.**

Ordinarily such a high percentage of a genus or a species (as is shown by **Quercus**) in a living flora would indicate it to be a dominant tree in the vegetation of that region, but the case is entirely different with the study of fossil floras and especially of those, which were deposited in lakes fed by river or streams. There are several factors such as the position of the site of deposition, the agency involved in the transport of plant organs, the habitat and habit of the plant, the nature of plant organs, the texture of he leaves, etc., which would largely affect the quantitative representation of species, therefore, before using the quantitative data pertaining to the occurrence of a particular fossil species, in interpreting the palaeoclimatic and palaeogeographic conditions during the geological periods a due consideration ought to be made for these factors. A brief discussion of the manner in which these factors affect the proportionate representation of a species in the fossil flora is given below:—

1) POSITION OF THE SITE OF DEPOSITION WITH RESPECT TO THE HABITAT OF SPECIES:—

Plants growing near the site of deposition undoubtedly stand a better chance of being represented in the sedimentary record than those which are growing at distant places; moreover the former will naturally contribute a larger number of leaves, flowers or fruits than the latter; and in the analysis of a fossil flora discovered from such a spot the former types would have an unusually high percentage than what actually existed. Therefore it seems that the method of counting individual specimens, which is perhaps the ideal in finding the dominant species in a living vegetation, may often yield erroneous results if applied in exactly the same way to fossil floras.

The Karewa flora is no exception to this rule; therefore, to avoid the introduction of an error on this account it is necessary to investigate how far this factor had affected the quantitative representation of dominant fossil species.

To establish a relationship that exists between habitat and quantitative proportion of the Karewa species the flora is divided into two groups:—the first group includes species that live in close vicinity of water in moist ravines; and the second embraces plants which grow in dry and remote localities away from any stream or lake, or on dry rocks, or such other hot and arid places in a forest. The number and percentage of species included in the two groups is brought out as under:—

Group	No. of species	Percentage from total of 102 species
(A) Plants near water	32	31.36
(B) Plants away from water	70	68 64

Group (A)

SPECIES THAT GROW NEAR WATER, IN MOIST RAVINES OR ON BANKS OF LAKES OR STREAMS:—

1. **Machilus odoratissima** Nees., (moist places only).
2. **Machilus Duthiei** King., (moist shady ravines).
3. **Phoebe lanceolata** Nees. (damp shady places).
4. **Ranunculus** sp.
5. **Clematis** sp.
6. **Indigofera hebepetala** Benth., (Moist shady ravines).
7. **Buxus Wallichiana** Baillon., (Moist shady places).
8. **Salix Wallichiana** Anders., (along streams).
9. **Salix tetrasperma** Roxb., (along streams).
10. **Salix denticulata** Anders., (along ravines).
11. **Salix acmophylla** Boiss., (along streams).
12. **Salix viminalis** Linn., (along streams).
13. **Salix** sp. (along streams).
14. **Populus ciliata** Wall., (sometimes on islands and banks of streams).

15. **Betula alnoides** Buch-Ham., (moist shady ravines)
16. **Alnus nitida** Endl. (on banks of hill streams and moist places).
17. **Quercus dilatata** Lindl., (sometimes moister places).
18. **Quercus glauca** Thunb., (moist ravines).
19. **Ulmus Wallichiana** Planch., (moist ravines)
20. **Ficus Cunia** Buch-Ham., (Banks of ravines).
21. **Rhamnus purpurea** Edgew., (moist ravines).
22. **Aesculus indica** Colebr., (moist places).
23. **Acer oblongum** Wall., (moist places).
24. **Acer Caesium** Wall., (in moist places sometimes).
25. **Rhus punjabensis** Stewart, (moist ravines).
26. **Rhus succedanea** Linn., (moist ravines).
27. **Juglans regia** Linn.,(sometimes moist ravines).
28. **Cornus macrophylla** Wall. (moist ravines).
29. **Olea glandulifera** Wall., (moist ravines).
30. **Wendlandia exserta** D.C. (Steep slopes and along river banks).
31. **Viburnum stellulatum** Wall. (moist shady places).
32. **Leycesteria formosa** Wall., (moist places).

Group (B)

SPECIES THAT GROW IN A FOREST, OR ON ROCKY CLIFFS, AND DRIER PLACES AWAY FROM WATER:—

Litsaea lanuginosa Nees.
Litsaea elongata Wall.
Berberis ceratophylla G. Don., (on cliffs or drier places).
Pittosporum eriocarpum Royle., (hot slopes).
Mallotus philippinensis Muell., (In forest and waste places).
Prunus cerasoides D. Don.
Pyrus Malus L.
Pyrus communis Linn.
Pyrus pashia Buch-Ham., (open dry hillsides or forest undergrowth).
Pyrus lanata D. Don.
Rosa Webbiana Wall., (In dry places).
Rosa macrophylla Lindl. (In forest undergrowth)
Cotoneaster bacillaris Wall.,
Cotoneaster microphylla Wall., (on rocks).
Cotoneaster nummularia Fisch. et Mey., (In dry places).
Cotoneaster sp.
Rubus fruticosus Linn., (hot dry places).
Spiraea sp. A.
Spiraea sp. B.
Desmodium podocarpum D.C.
Desmodium laxiflorum D.C.
Desmodium tiliaefolium G. Don.
Desmodium nutans Wall., (hot places).
Desmodium gangeticum D.C., (dry grassy places).
Desmodium latifolium D.C.
Parrotia jacquemontiana Dcne., (dry places).
Buxus papillosa C.K. Schn., (dry arid hills).
Populus nigra Linn.
Betula utilis D. Don., (Rocky steep ground).
Alnus nepalensis D. Con., (Forest tree of river banks).
Carpinus faginea Lindl.
Carpinus viminea Lindl.
Corylus ferox Wall.
Quercus semecarpifolia Smith.
Quercuc Ilex L., (Dry hot places).
Quercus dilatata Lindl.,
Quercus incana Roxb., (hot places).
Ulmus laevigata Royle.
Ulmus campestris Linn.
Elaeodendron glaucum Pers.
Rhamnus virgata Roxb.
Berchemia floribunda Wall.
Sageretia oppositifolia Brongn.
Leea aspera Wall., (Forest undergrowth).
Skimmia Laureola Sieb. et Zucc.
Acer **pentapomicum** J.L. Stewart., (dry valleys).
Acer pictum Thunb.
Acer Caesium Wall., (dry open places).
Acer villosum Wall.
Rhus Cotinus Linn.
Lannea grandis Engl.
Engelhardtia Colebrookeana Lindl.
Cornus capitata Wall.
Hedera nepalensis K. Koch.
Marlea chinensis Lour.
Myrsine africana Linn.
Myrsine semiserrata Wall.
Fraxinus xanthoxyloides Wall., (dry places).
Fraxinus excelsior Linn.
Syringa Emodi Wall.
Hamiltonia suaveolens Roxb., (dry hot places).
Randia tetrasperma Benth., (Rocky slopes or dry ravines).
Viburnum cotinifolium D. Don.
Lonicera quinquelocularis Hardw., (warm dry places).
Inula cappa D.C.
Pinus longifolia Roxb.,
Pinus excelsa Wall.
Abies Webbiana Lindl.
Picea Smithiana Boiss.
Cedrus Deodara Loud.

The most dominant plants in the fossil flora are represented by five species of oaks, namely,

Quercus semecarpifolia Smith.
Quercus dilatata Lindl.
Quercus Ilex L.
Quercus glauca Thunb.
Quercus incana Roxb.

Except **Quercus glauca** Thunb., which grows in moist ravines and some trees of **Quercus dilatata** Lindl., which occasionally occur in moist places, the rest of the dominant species fall in group B. Therefore, their dominance in the Karewa flora inspite of the disadvantage that their habitats lay in remote places far removed from the site of deposition, probably suggests that their higher percentage in the fossil beds is not much exaggerated and oaks were dominant trees in the vegetation of the Kashmir Valley during the Lower Pleistocene times.

(2) MODES OF TRANSPORT:—

The Karewa flora, as revealed by the foregoing analysis, is composed of a large number of species that now grow in drier places away from water, and taking into consideration the modern aspect of the fossil flora it may be reasonable to suppose that they probably grew in places far removed from the site of deposition. Their representation in the fossil beds, therefore, suggests that they had evidently been transported by wind or carried down by hill torrents from their parent plants to the lake.

Wind plays an important role in bringing about the dispersal of fruits, seeds or even fallen leaves and blows them away to long distances from the parent plants. A strong wind blowing in a favourable direction may bring moderately lighter plant parts in larger numbers to the site of deposition or when blowing in an opposite direction it may act as an unfavourable factor and carry away all specimens, which have even reached the site of deposition.

The efficiency of wind as a means of plant dispersal is well known to naturalists. Pollen grains, spores and bits of plant material are often carried to very long distances in a wind storm. Ridley (1930, p. 2) cites the observations of Darwin, who records in the "Voyage of the Beagle" (Chap. 1, p. 5. ed. II) several instances when he noticed the falling of dust on ships moving at long distances from land; this dust was not examined but in another instance "samples of dust which fell a few hundred miles north of Porto Praya, Cape Verda Isles sent by Lyell, consisted largely of infusoria with siliceous tissues of plants". Winged pollen grains of Coniferales are capable of flights over still greater distances. One often sees in the hills thick clouds of yellow sulphury pollen powder flying to long distances.

Wind is not only capable of carrying microscopic plant parts but it also blows away lighter seeds and fruits, often to long distances. Schimper (1903. p. 80) cites an observation made by Treub and remarks that "seeds can be carried by wind over stretches of the sea at least twenty nautical miles in width, for he found in the interior of the island of Krakatoa, which is that distance from Java, three years after the eruption which had covered the island with a thick sheet of lava, eleven ferns, two species of Compositae, and two grasses whose spores or seeds could have been carried thither by means of the wind alone". Heavier fruits and seeds which are equipped with wings or such other contrivances are better fitted for flight over considerable distances. Ridley (**loc. cit., p. 72**) records many interesting observations made by him on dispersal of winged fruits and seeds in Kew Garden, Surrey, and the Botanic Gardens at Singapore To quote only two instances, he found that in a moderately strong wind samaras of a 50 ft. tall tree of **Acer pseudoplatanus** were blown to a distance of 40-93 yards; whereas a 20 ft., high tree of **Fraxinus excelsior** was able to send its samaras to a distance of 134 yards in similar atmospheric conditions. Ridley further suggested that they can fly for still greater distances if the breeze is a little stronger and the surrounding country be flat and plain.

Strong winds carrying a large number of dried leaves, smaller twigs etc., to considerable elevations and long distances is a common sight in the Punjab plains in the months of April and May. Ridley (loc. cit., p. 5) gives some statistical data regarding the distances to which leaves are blown away by winds. He mentions from a paper by Volger in Flora, Bd. 89, 1901, p. 71 some observations made by Coaz, Christ and Muret on the distances to which leaves were blown away by wind in the Swiss Alps. "Coaz found beech leaves blown on to glaciers at a distance of from 5 to 11 kilometres (approximately $3\frac{3}{4}$ to 7 miles), and chestnut leaves at a distance of 12 kilometres from the nearest trees. Christ found beech leaves blown 15 kilometres, and Muret found the leaves of **Pyrus (Sorbus) aria** at a distance of from 15 to 20 kilometres (about 14 miles)".

Wind affects dispersal of plant material in still another way; it produces covection currents in lakes and seas, which carry floating plant matter along their direction often to very long distances. Heavy storms raging in the direction in which the site of deposition occurs, may bring large amount of dust and shower it on floating plant material, which may sink to the bottom of a lake earlier. Thus in a strong wind layer after layer of plant matter blown from the surrounding vegetation would be more speedily buried than in quieter atmospheric conditions.

Water is another equally important factor, which affects the prevalence of plant organs in fossil beds. A heavy shower of rain is capable of

washing away uniformly from all over the area large quantities of leaves, fruits, seeds, and pieces of twigs from various distant places and from different altitudes. This variously mingled heterogenous mixture of plants would be spread or deposited, as the case may be, at the same place at the bottom of slope. Similarly a perennial hill stream may constantly bring plant material from all over the country through which it passes and may lay it down at the bottom of an estuary or a lake. Floating leaves, unless they are soon laid down at the bottom, are often drifted away to long distances under the influence of water currents. Thus, there is every likelihood of a mingling of two different floras, which might be growing on opposite banks of a lake several miles apart. Capacity of marine currents to carry fruit and seeds from one place to another locality lying at a distance of hundreds of miles in different geographical and climatic zones is shown by observations of naturalists. Linnaeus (cited by Schimper, 1903, pp. 28, 29) found fruits and seeds of many tropical American plants on the coast of Norway, where they were brought by oceanic currents from the West Indies. The pioneer observations of Hemsley (1885), Guppy (1889) and Schimper in the Indian and Pacific Oceans have shown that water currents play an important role in bringing about dispersal of plants and carrying them to long distances over unrelated areas. Guppy (1889) made interesting observations on seeds and fruits found in drifts along the coasts of Islands of Grenada, Jamaica, Tobago, Trinidad, Turks Islands and Azores and showed that these plants have drifted along oceanic currents for several hundred miles from far off lands. These fruits and seeds had often germinated on islands, which are geographically so far away and have thus raised difficult problems for those, who (not knowing this) attempted to explain the present peculiar distribution of these species. Guppy began his work on these stranded fruits and seeds and found out their original home by following his way along the islands. He made several interesting bottle experiments and studied the course of different water currents in the Atlantic. The results of his laborious studies, extended over ten years, are embodied in a well written treatise referred to in the bibliography.

In the summer of 1923 Prof. Sahni, on his way to Kashmir, studied the drift vegetation of a river in flood near the small town of Bhimbar on the southern side of the Pir Panjal Range. Sahni gathered drifting plant material consisting of leaves, fruits, seeds and cones flowing down the river and identified them by walking up the river to trace the nearest source of the parent plant—a method essentially similar to that followed by Guppy over a much longer distance at sea. Interestingly enough, Sahni found a few female cones of **Pinus** among the gathered material, most of which consisted of leaves of **Nerium, Rosa,** and other shrubs or trees, which were growing near the bank in the neighbourhood of the place at low altitudes. He observed no pine tree at that altitude within an area of several miles. Prof. Sahni continued his upward march and found that the nearest tree that could contribute its female cones to the river sediments at Bhimbar was growing several thousand feet higher up at a distance of over 15-20 miles from Bhimbar. If this material were to be fossilised and subsequently discovered at Bhimbar by some untrained investigator he might easily have been led away by fascinating facts and would have wrongly interpreted geographical and geological conditions of the place on finding those female cones of pine. This instance, related to me by my guru, has always served me as a caution against deriving hasty conclusions in a passion for research.

The rate at which a stream flows through a particular area should also be considered as an additional point of interest. Generally conditions for fossilisation along a swiftly moving stream are not suitable; and most of the plant matter is often strewn into pieces before it reaches a suitable site of deposition. Moreover, heavy particles of clay or sand brought by swift waters make a thick layer in which the embedded leaves are either partially destroyed or get disfigured by coarser sediments. A slowly moving stream, on the contrary, is better in this respect, because the plant matter is only partially destroyed and the layers are also thin and composed of finer particles. Usually leaves transported and deposited by such streams in fine grained sediments are well preserved regarding details of venation. Quieter waters of fairly deep lakes or ponds provided ideal conditions for fossilisation as plant material rots and sinks to the bottom fairly slowly and in regular layers.

The nicely preserved nature of the leaves discovered in the Karewa beds at some places suggests that they had probably not been washed down from long distances.

(3) HABIT OF PLANT

Leaves, fruits or seeds of taller trees in a moderate wind are borne for longer distances than those of dwarf types. Thus trees and tall shrubs are better suited for sending their leaves, fruits etc., to the site of deposition in larger numbers than undershrubs or herbs. Generally leaves of the latter types are not dispersed to

a great distance from the parent plant due to their low habit and unless they are transported by heavy rain at the proper time they are largely likely to remain unrepresented. The great paucity of herbs and undershrubs in the Karewa flora may probably be due partly to this factor.

(4) NATURE OF PLANT ORGANS

Ordinarily lighter and smaller simple leaves, which are shed singly, are better suited for dispersal by wind or water than the compound leaves with many leaflets. Other heavier parts such as cones, unwinged fruits, dwarf shoots of pine, pieces of twigs etc., cannot be easily transported either by wind or water, so they are likely to be rarely represented in the fossil flora. Winged fruits, seeds, or those equipped with such other contrivances are to be found in larger numbers. In this connection it may be mentioned that except fruits of **Trapa**, two incomplete cupules of Quercus and one small fruit of **Hedera**, all other fruits in the collection are winged samaras, achenes or winged seeds.

(5) TEXTURE OF LEAVES

Strong leaves with coriaceous or sub-coriaceous texture, which can withstand prolonged weathering and rotting in adverse conditions, are the most suitable and likely to be represented in larger numbers. Broad and thin leaves or spring foliage, which unlike coriaceous leaves are easily crumpled into fragments in transportation, are the least to be found. An examination of Karewa species from this point of view (see Table II) shows that all the quantitatively well represented species are those which possess coriaceous or sub-coriaceous leaves.

(6) SEASON OF THE YEAR

Most forest trees, excepting evergreen species, shed their leaves in autumn, and if active deposition is in progress at such a time, a larger number of leaves will be able to enter the sedimentary record; whereas if the time of deposition coincides with spring, trees will be bearing young leaves so the layers formed at a particular place during this season will not have much leaf material. The flowering season will naturally contribute flowers and pollen grains while the fruiting time will add more fruits.

(7) KINDS OF TREES

Deciduous species are likely to be represented in larger numbers than the evergreens. The accompanying Table (II) gives a comparative account of several features of the fossil species. The last two columns are intended to give the nature of the plant parts. This table also gives the results on rotting of leaves in the laboratory; in the last column are given the plant parts which are actually discovered in the beds. The author is not in a position to give any satisfactory explanation for the absence of such plant parts, which are otherwise suitable in all respects for entering the sedimentary record. This may be due to incomplete collection and a study of further material might reveal the presence of these parts.

It is clear from the foregoing analysis that most of our dominant species have some factors, which are favourable for their larger representation. But a few factors in some species are also unfavourable. As a matter of fact most of the factors are favourable, and it is quite probable that the overwhelming majority of some species over others is to be explained by their possessing fortunate characters. But after taking a due consideration of all these factors one is irresistibly forced to the conclusion that there existed in the Kashmir Valley during the Pleistocene fairly extensive oak forests with conifers and several broad-leaved species.

A wild species of lac insect in India

S. Mahdihassan

S|0|In., G|92|-lac|In.—India produces annually some 48000 tons of lac. The intense infestation of the Mysore lac insect is contrasted with that of the world lac insect. The number of insects in the encrustation can be counted by the number of three dot patterns. The generation of the lac progeny is explained.

The lac insect yields three useful products, a dye, a resin and a wax ; their exploitation, however, has differed during the course of history. The dye is contained within the body. Its skin being very delicate a coat of resin is secreted, to afford protection. Wax is secreted from special glands and serves as a frame work (1) for the support of the main secretion of lac. Formerly the dye alone was preferred, today it is thrown away while shellac is used instead. India produces about 48,000 tons of lac every year which makes it, next to that of silk, the most useful insect to man.

Lac is grown from Kashmir to Mysore and from Sindh to Tonkin, yet it is said that there is only one lac insect. On the face of such a statement there can be no question of a wild lac insect being there as this would single it out from others which are not.

However lac is not cultivated everywhere in India, there being localities where it is merely collected, when natural infection makes it worth while to do so. Enterprising people have realised that lac cultivation offers little technical difficulties. Their expectations and trials have nevertheless ended in repeated disappointments. With less ended in repeated disappointments. With such experience they have been made to believe that some mysterious influence of climate or soil is the real inclement factor in lac cultivation. In the second book that was ever printed in India, at Goa, in 1563, its author, Garcia de Orta writes, in his "Colloquios dos Simples e Drogas e Cousas Meddecinaes da India", as follows. "Here in Goa a boy brought me a branch of (**Zizyphus jujuba**) tree . . . (which) bears little lac (in Goa) hence they do not value it (for they say) that the soil is not suited for its pro-

Fig. 1.—Mysore lac insect infesting sharea talura.

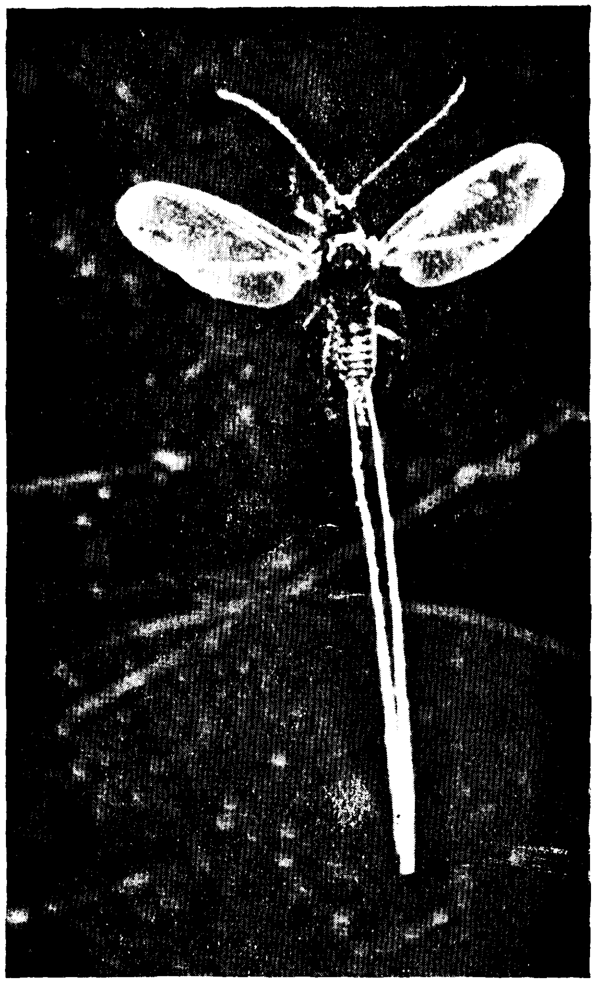


Fig. 4.—Winged male.

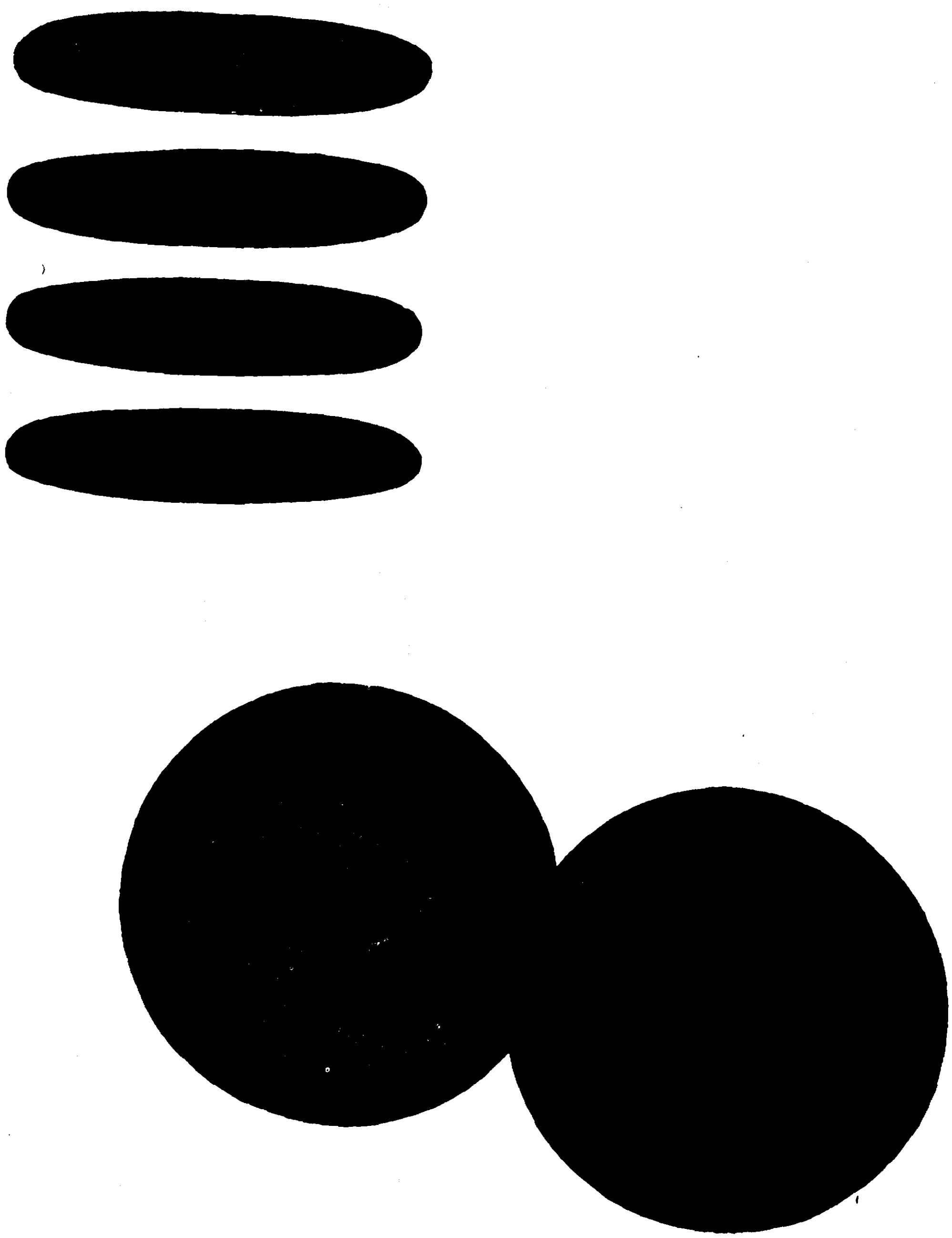
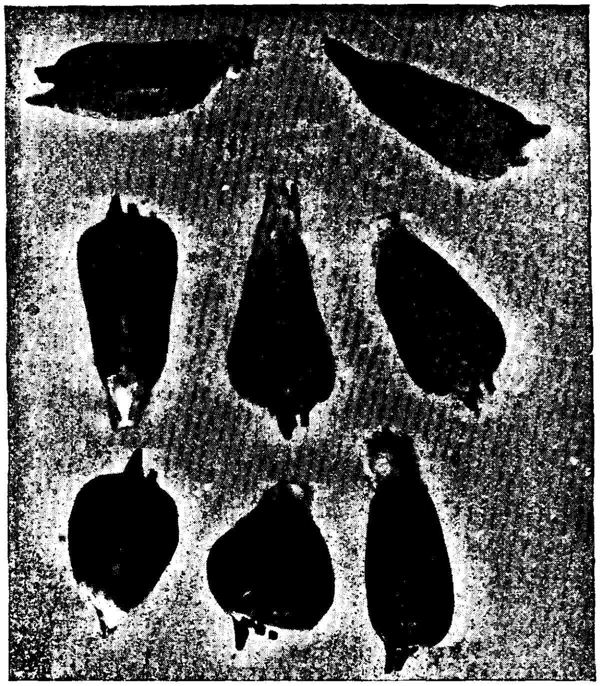


Fig. 2.—Wild lac (*Lakshadia commeneris*) infestation.

Fig. 2 a. **Crown Shaped Cell K (not at its best)**

Fig. 2 b. **Crown Shaped Cell at K.**

Fig. 3. Crown Shaped Cell.



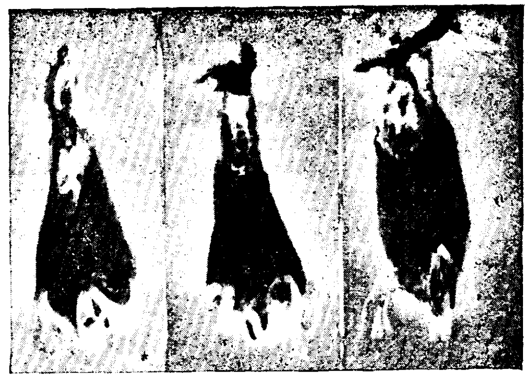


Fig. 6. Loe ir.sects with their Wax Armature

Fig. 7. Loc insects with their ventral or oral ends consed with wax. Note one insect is entirely free of wax·

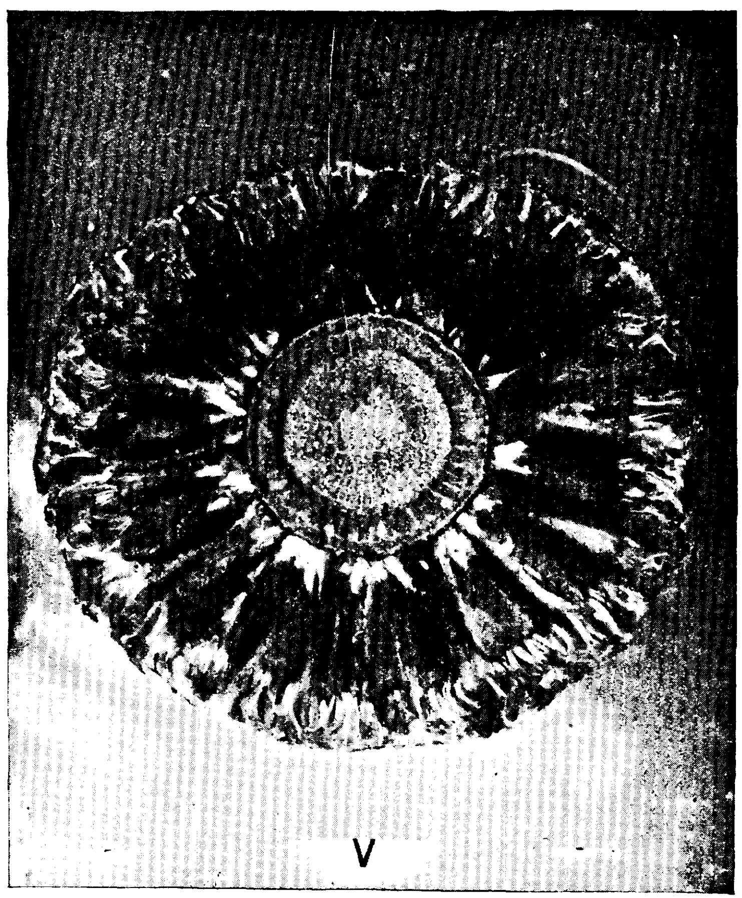


Fig. 5. Cross-section of tivin showing growen cf loc insects.

duction." In Sind lac production is confined to a very small area and attempts have been made to extend it. An official report published, as late as 1921, reminds one of Garcia, for it also says "no definite reason can however be assigned without careful local investigation". The defect lies not with local conditions but with the insect's constitution.

Being wild, the lac insect, **Lakshadia communis** was first discovered from Bombay in 1860 by Carter, and it has been found distributed all over South India (Goa, Travancore, Coromandal coast, Madras, Hyderabad and Mysore states). Being easy to procure it came to be illustrated as early as 1567, when C. Clusius printed, at Antwerp, a Latin edition of Garcia's book. In 1791 Roxburgh published an illustration of stick typical of **L. communis.**

The Mysore lac insect, **L. mysorensis** acquires a striking appearance when it infects its favourite plant **Shorea talura** tree (Fig. 1). The wild lac insect **L. communis,** on the contrary is not reproductive enough to give such an intense infection. The colonies of lac insect become conspicuous by their white appearance, due to their secreting a white wax powder. Their excreta is honey dew, consisting of glucose and fructose, which is prevented from adhering to the surface of lac by means of this powdery wax.

One fine specimen (Fig. 2) of the wild lac insect forming an encrustation of three to four inches long, like a small chunk was collected from **Acacia concinna,** at the end of the monsoon season in Bangalore. The surface is seen dotted with groups of three white spots, something like the sign of "therefore", . . . Each group of three dots represents a living insect within the encrustation which enables us to count the insects that have formed the colony. When an encrustation, as Fig. 2, is treated with alcohol all living insects would appear red and plumpy, while if there be dead ones they would appear much darker and shrivelled. Now the question can be asked where are the mother insects which formed the encrustation seen as Fig. 2. Dissolving it in alcohol there would appear only one dead insect, marked K, in Fig. 2.

In Fig. 2a, the encrustation in general is seen at its best. The encrustation alone was nearly 10.9 cms. long. The twig was 0.8 cm. in diameter. The dry encrustation with the twig weighed 13.4 gr. The number of insects forming the colony could not be counted in this case. But from another specimen of encrustation as many as 1,335 fully mature females formed the progeny, and came from a single crown shaped cell. In Fig. 2a, the crown shaped cell K, is not seen at its best, which is the case in Fig. 2b., K. Fig. 2a shows the encrustation turned on its back, as it were, in Fig. 2b it is seen at its side. Both are magnified 11:10.

It has been found that each such chunk of lac would have one dry cell which, when well formed, resembles a crown and has been called a crown shaped cell. Here the shape is rather distorted but it has been well illustrated elsewhere (2). The crown shaped cell in Fig. 2 would resemble Fig. 3 derived from a similar chunk of lac. The normal lac cell offers no special features, it is a round object and resembles a small pill. A crown shaped cell shows its wax glands curiously developed and their secretion is also expressed outside through the layer of lac resin. These crown shaped cells are dead mothers of generations which formed these chunks. Living crown shaped cells have been actually observed to give rise to young larvae and their final development upto small encrustations of lac has been observed.

The crown shaped cells give rise to a normal generation and the main encrustation or chunk is formed by them. But the generation born of these chunks, is entirely different. When the larvae are fully mature they turn out to be winged males, Fig. 4, and the colony dies from want of a female. Roxburgh has actually illustrated, in 1791, a generation consisting of pure male larvae, only he could not interpret such a strange phenomenon; this has been explained elsewhere by me (2). Some larvae of winged males, transported by flies, change their sex and become crown shaped cells when they continue to maintain the species which would become extinct but for sex reversal. The problem has been analysed to the stage when the eggs are fertilised. When there is excess of moisture as in mother insects feeding on trees during the monsoons the male sex is determined; dry weather conditions favour the female sex formation. Such an insect, by its great sex ratio variation detrimental for propagation, can never be used for cultivation. I have never known any locality where this insect has been used for propagation. Next to **L. communis,** the Sind lac insect, **Lakshadia sindica** behaves very similarly but not so badly. While so much has been said about lac it might be worthwhile showing its inner construction. An earlier French writer has called stick lac the honey comb of the lac insect. The insect is gregarious and the secretion of the neighbouring insects fuses together to form a common encrustation such as is seen in Fig. 2. On **Ficus mysorensis,** the insects grow all around a vertical twig and

form a cylinder or a collar of lac encrustation, but on an inclined twig the surface towards the earth (V) would show a better growth of lac insects than of those on the opposite (D), as is evident in a cross section of a twig (Fig. 5) collected at the end of the monsoon season. The encrustation otherwise would not have shown such a difference in the growth of insects.

When stick lac is dissolved gently in cold alcohol the resin is dissolved and insects, with their wax armature, are seen. In Fig. 6 three insects are seen, from such a colony as is represented in Fig. 5, with their wax adhering to them. This wax has been removed from other specimens and Fig. 7 shows the insects with their ventral or oral ends still covered with lac, except one insect which is entirely free from all wax. The lac dye is contained within their bodies and gives them the dark appearance shown in the picture.

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Explanations of illustrations.

Fig. 1 : **Lakshadia mysorensis** encrustation on **Shorea talura.** This is the appearance of a tree under artificial cultivation.

Fig. 2 : **Lakshadia communis** encrustation formed on **Acacia concinna** by a generation of insects swarming from one mother cell, now dry and marked K, crown shaped cell.

Fig. 2a : Ventral aspect.

Fig. 2b : Encrustation on its side.

Fig. 3 : Crown shaped cell, such as is seen in Fig. 2, K, much enlarged, it is not typical in appearance.

Fig. 4 : **Lakshadia communis**, winged male, magnified.

Fig. 5 : Cross section of a twig of **Ficus mysorensis**, with lac encrustation formed by **Lakshadia communis** ; V, ventral side ; D, dorsal side. Magnification, 38:10.

Fif. 6 : **Lakshadia communis**, adult female insects bearing the armature of hard wax. Magnification, 38:10.

Fig. 7 : **Lakshadia communis**, adult female insects freed from wax excepting on their oral or ventral surface. Magnification, 38:10.

Soil Conservation in Punjab Through Voluntary Efforts and its Progress.

—By : S. Mehr Singh, B.Sc., (Agri.), P.S.C.S.,
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Hoshiarpur.

G|1114|Pj., G|2612|Pj., G|1214|Pj. This article deals chiefly with the soil erosion problems of the Punjab and stresses the need for cultivating the public mind and opinion in general in this respect and bringing home to every son of the soil the great havoc which their indiscriminiate felling and grazing does to the soil, which slowly and stealthily becomes unprotected and unproductive.

A scheme is put forward where a working unit is a village. An exhaustive line is followed on the co-operative basis. It is hoped by doing so the greater part of the work will be accomplished. Although it may seem a tremendous task but slowly and persistently pursuing this policy and adopting it on an extensive scale later its outcome will not be a mean achievement.

The colossal national loss through soil erosion has been fully realised in the west and adequate protective measures have been adopted on a very extensive scale. There is huge area liable to erosion in this country and steps with varying success are being taken in various provinces to cope with this immense problem. The Punjab, with its extensive mountainous and Sub-mountainous area come in for a comparatively greater loss as compared with some other provinces and needs extensive efforts of all concerned ; it is estimated by the Forest Department that about one crore and 49 lacs acres are thus affected. This land of five rivers has to its credit several new ventures such as consolidation of fragmented holdings, rural reconstruction and road transport work, which are executed on co-operative basis. Experiment on soil con-

servation through voluntary efforts as against through Govtt. executive measures was started in this province as early as 1938. The progress in the initial stages was slow but once the experiment became successful and the detailes were worked out, its success has been remarkable. The most speedy and the cheapest way to check erosion is to close the area to grazing and indiscriminate felling of trees, so this is done by compulsory closures under various acts. Forest department is doing good work on these lines and progress on the whole is fairly commensurate with the staff available but as a whole only fringe of the problem is touched. Govtt. efforts have to depend on funds available, and thus the progress is bound to be slow. If on the other hand the masses could be made to realise that protection is in their interest and they should themselves make necessary arrangements, then there could be no such limitation and work could be immeasurably expanded with little expense to the Govtt. This has been the basis of formation of cooperative societies in the province for soil conservation with various nomenclature such as Forest societies, Soil conservation societies, and societies for terracing etc.

SCHEME

The working unit is a village. All the persons who have a right on the village land are eligible to become members. Area offered is either partitioned land lying waste or the village grazing ground, only *that land is taken which* is liable to erosion and is un-cultivated or that which is unproductive sand and needs improvement. In some cases training of hill torrents and reclamation of portion of its bed is the object in view. If it is common grazing ground then it is usually divided into two blocks one is left for grazing while other is closed to grazing. Members voluntarily apply for closure of their land under conditions which they give in writing and period for which closure is intended is also stated. It is not necessary that all persons having right in land should join before the society could be registered, persons owing $\frac{3}{4}$th area contemplated to be offered for closure are considered enough. Rest of the right holders join gradually as work proceeds. Society is registered under the Cooperative Act earlier than the closure of land which usually takes place later on. Some societies whose area is not liable to be damaged by non-members do not get their area closed under the statute since the members can be taken to task by the society itself for infringement of its regulations. Model bylaws with necessary amendments are adopted. These bylaws provide for election of executive committee of 5 or more members with President, Treasurer and a Secretary; lay down executive committee's duties and duties reserved by the general body ; make provision for appointment of a guard detailing his duties and lastly for the method of distribution of income. Society by virtue of registration under the Act acquires corporate capacity. Guard is appointed by the committee subject to the approval of Divisional Forest Officer, who appoints him a Forest Official and thus entitles him to make damage reports. Damage reports go to Forest department which either compromises these and realises compensation or takes action under the statute if compensation is not paid. A plan of work is drawn up by the Forest department or failing this the work of conservation, improvement or training of hill torrents is done on the *advice of the Forest department. Extensive* protective works are undertaken as also plantation of various grasses, shrubs and trees. Members give either manual labour if the society has little funds, otherwise cost of work is met from the funds of the society. Govtt. also gives some grant on the condition that equal amount is contributed locally by the villagers. Society prepares a record of rights after consulting revenue record and it is revised annually, this forms the basis on which income is distributed. After meetng its expenses the net income is divided as below :

(a) 5% is set apart for Reserve fund.

(b) 5% is set apart for land improvement fund.

(c) rest is divided amongst members according to their right in the land.

Secretary maintains the record which consists of Cash book, ledger, register of members, register of right holders, progress register and proceedings book. Accounts of the society are annually audited by the Cooperative department, when general meeting is held and new office bearers are elected by majority of votes for the year ensuing. Secretary also maintains day to day record of funds of the executive committee. The bylaws which these societies adopt are mostly on the lines of bylaws adopted in other Cooperative societies of the province ; the only changes being that which are necessary to suit these particular type of societies. Sub-Inspectors of the Cooperative department work in advisory capacity ; just as the Forest officials tender advice in their own demain of forest technicalities. Practical work is supervised by the Forest department but now Sub-Inspectors have got training by attending various classes held by Forest department and are in a position to lend a hand in this work too. Application for

This activity giving proper details prior to 1938 and it was being shown as miscellaneous work under better forming. This accounts for the meagre and brief figures that are available. It is only last year that a separate chapter with extensive details is given to this subject and hence forward it will be possible to comment on the progress withgreater precision. Figures that were available since the start are given in the table below :—

Year	No. of Socs.	Member-ship.	Working Capital.	Profit.	Income.	Income Distributed.	Area controlled in Acres.	Area reclaimed	Seedlings plated	Staff Inspectors	S. Is
1925	6	321	4	59							
1926	4	129	238	33	600						
1927	5	249	1542		3500			227			
1928	5	256	3144	127							
1929	5	282	914	181	3015	2295	5442	69			
1930	5	280	1227	297	4016						
1931	4	254	1753	261	1047			15			
1932	7	424	3622	391	3866	1390	5662				
1933	7	475	4172	440							
1934	6	429	5100	95							
1935	8	573	6659	198				150		There was no Special staff for ihis work prior to 1938.	
1936	8	647	8082	271							
1937	11	809	12488								
1938	12	877	15931							2	10
1939	63	2165	13292	856			37000			2	10
1940	99	4271	13026	51						2	10
1941	154	5804	33082	1446						2	10
1942	233	7920	42498	3068						2	10
1943	321	12105	98813	196						6	25
1944	453	17565	54000		25537	20087				8	46
1945	489	21447							77962	12	47
1946	650	23763	248517		262229	152149	251620 acres	2947¼ acres	802965 Cuttings. 670 acres seedlings.		

closure is usually obtained at the time of registration. Special patwaris lent over, out of the Revenue staff, or by the Forest Deptt prepare plans and record of the area to be closed. Papers are sent for notification by the Forest department after scrutiny on the spot.

PROGRESS.

The scheme was started in the province as early as in 1938 but it was in the experimental stage in the beginning so progress was bound to be slow. Since the number of societies in the beginning was small so this activity was not discussed in detail in the annual report. There was no separate section for this activity giving proper details prior to 1938 and it was being shown as miscellaneous work under Better Farming. This accounts for the meagre and brief figures that are available. It is only last year that a separate chapter with extensive details is given to this subject and hence forward it will be possible to comment on the progress with greater precision. Figures that were available since the start are given in the table below:

At present soil conservation work is going on in 9 districts named below :—

1. Hoshiarpur
2. Gurdaspur
3. Kangra
4. Ambala
5. Gurgaon
6. Rawalpindi
7. Campbelpur
8. Jhelum
9. Gujrat

Figures for the cooperative year ending 31.7.46 are very encouraging and few of these are given below:

1. Societies registered during the year: 160 with 3747 members
2. Total No. of societies: 650
3. Membership: 23763
4. Working Capital: Rs. 2,48,517
5. Total area controlled: 251620 acres.
6. Total area brought under cultivation after reclamation: 1412 acres
7. Govtt grant given through cooperative and Forest departments: Rs. 83,911 to 375 Socs.
8. Contributions made by societies for Soil Conservation: 75,957
9. No. of socs. that have guards: 324
10. Staff employed:
    Inspectors: 12
    Sub-Inspectors: 47
    Patwaris: 4
11.
12. Total income realised upto date: 10,28,686
13. Amount distributed to rightholders during the year: 1,52,149
14. Practical work of Soil Conservation done during the year:
    (a) Terracing: 9889 acres

		Nara Bana	
	Sirkanda or Nara		Srikanda
(b) Plantings		1442 acres	87758 ft.
	Live hedge spurs		Double spurs
(c) Spurs:	10463	78	29576 ft.
(d) Earth bunds ..			451 bunds
(e) Gully plugging ..			1390 bunds
(f) Cuttings of various trees planted			8,02,965
(g) Guide Channels			11
(h) Contour trenching ..			2800 trenches
(i) Seeds of different kinds			670 acres (103 mds. 9 seers)
(j) Shisham Nursaries ..			12
(k) Bhabhar plantation .. (used in the manufacture of paper).			13 acres
(l) Grafting of trees ..			235 trees
(m) Silt clearances			476 acres
(n) Kahi stubbing ..			75 acres
(o) Reclamation shrubs ..			6450 feet.
	Number	Length	Repair
(p) Contour Bunds and their repairs	27	2972 feet	116360 feet
(q) Spill ways. ..			15

DIFFICULTIES

The encouraging figures of progress might be taken to mean that work is easy and could be accomplished under average circumstances. This however is not the case. The staff put on this work is usually the most capable and seasoned workers with long experience and they have to face innumberable difficulties before they succeed in their mission. Common types of difficulties experienced in the organisation of these societies are given below :

1. The possession of few acres to a Punjabi owner is all that he has, and he rightly treasures these. To this may be added the fact that such areas are usually not well developed in the matter of transport and education as compared to plains, and people are conservative and do not take kindly to new experiments. Very consistent propaganda sometimes for months together is necessary before staff succeeds in bringing round the necessary number of owners to start the society.

2. In the case of common grazing land tenants are accustomed to cut grass and fell tress, although they have no such rights according to the revenue record. The entire income of the area once it is protected, has to be distributed to owners in the proportion of their rights. Thus tenants are the losers. This has been remedied by having two blocks of common grazing ground, and thus ensuring status quo in one block at least but tenants who were formerly using the entire common grazing on more or less equality basis with owners, with some grazing facilities even in partitoned area, feel this an encroachment on their rights and make stout opposition to this scheme. Litigation crops up and here are cases which have went up to high court. Staff has to work hard to reconcile both the elements and find via media.

3. The influential rightholders, who have forcibly taken possession of a portion of common grazing ground in excess of their shares also stoutly oppose the scheme ; as they will have to surrender the illegal benefit, that they were thus driving.

4. The partitioned land of different owners which is damaged by hill torrent, is usually not of the same quality. Few thoughtful and industrious owners may have taken the lead and improved their plot by sowing trees or income yielding grass and thus they suffer if they pool the total income, which is later on divided uniformly on the basis of ownership of land given for reclamation.

5. Co-operative point of view is rarely realised by the other departments of the Government. Co-operative department is in fact no department in the sense that it has got some separate end in view. All that the co-operative department does is to provide an organisation which does the work of may be agriculture, education, rural reconstruction or forest departments. Since other departments' work is carried on so there can be no replacement of the department that is concerned and thus there need not be in rivalry but unfortunately this is not so. There is another logical difference. The co-operative department works on democratic lines with the ideal that people should increasingly do their own work as much as is possible and classification of A, B and C class is based on this assumption. A best co-operative society is that, which should not stand in need of any help from the co-operative staff except annual audit of its accounts and there are even instances in which this even is arranged by the society without recourse to the staff. This ideal is directly opposed to the view held by many of the executive departments and is always stoutly opposed. There is no help to this and this opposition cannot lead to the abandonment of this ideal on which the entire fabric of cooperation is based.

THE FLORA OF THE KAREWA SERIES OF KASHMIR AND ITS PHYTOGEOGRAPHICAL AFFINITIES WITH CHAPTERS ON THE METHODS USED IN IDENTIFICATION.
(CONCLUDED)

Dr. G. S. PURI.

Explanation of abbreviations used in the accompanying table No. II.

D — Deciduous
S.D — Semi-deciduous
E — Ever green
C — Compound
S — Simple
Co — Coriaceous
S.C. — Semi-coriaceous
T — Thin
L — Large
S — Small
Cn — Cone
F — Fruit
A — Large & heavy fruit
B — Small & light fruit
W — Winged
U — Unwinged
C(3) — Compound leaf with 3 leaflets
V.L — Very large
V.S. — Very small.

7

G. S. P. & G. D. S., Photo.

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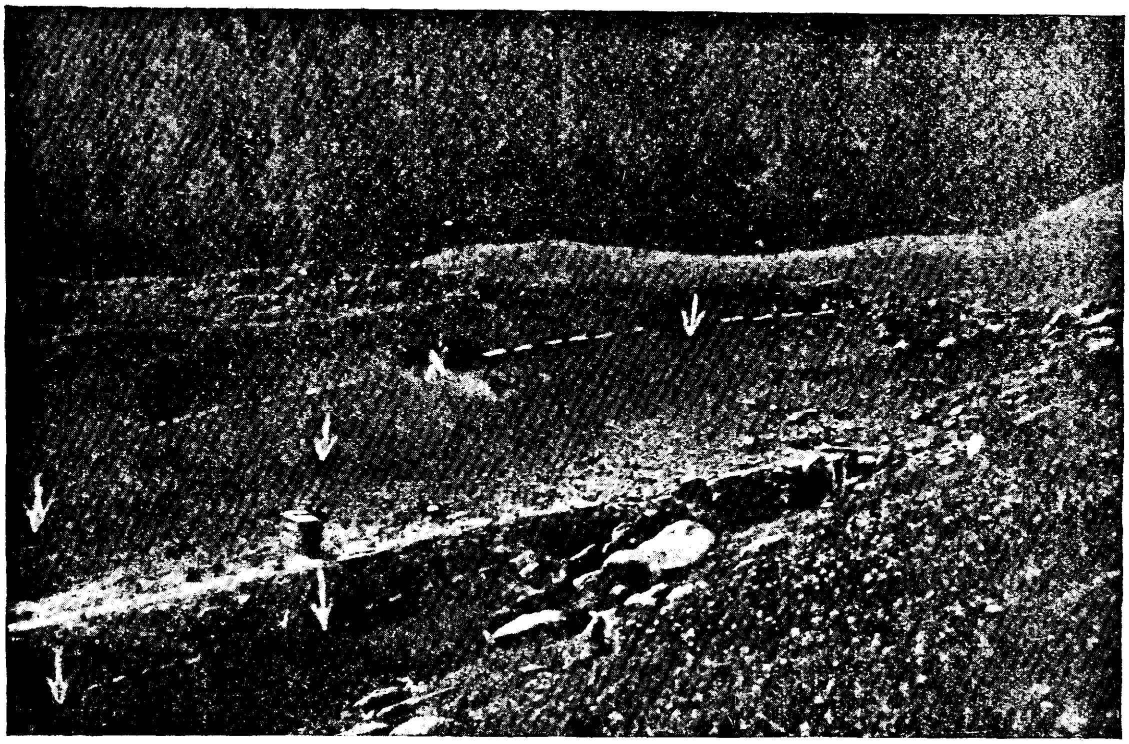

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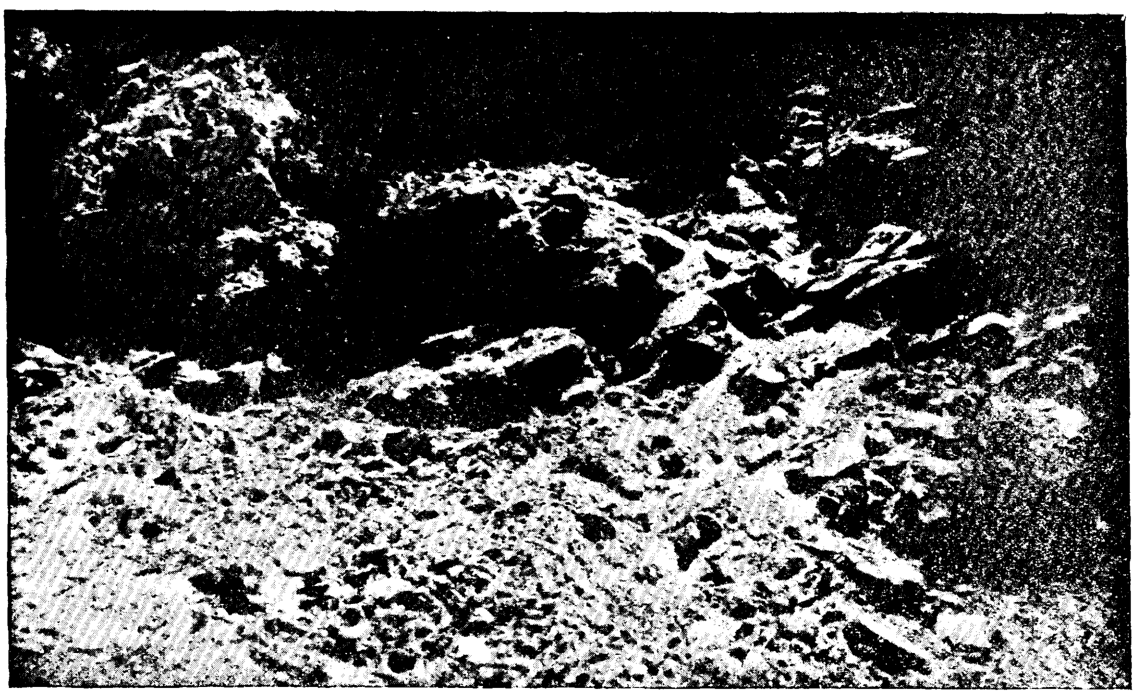

G. S. P., Photo.

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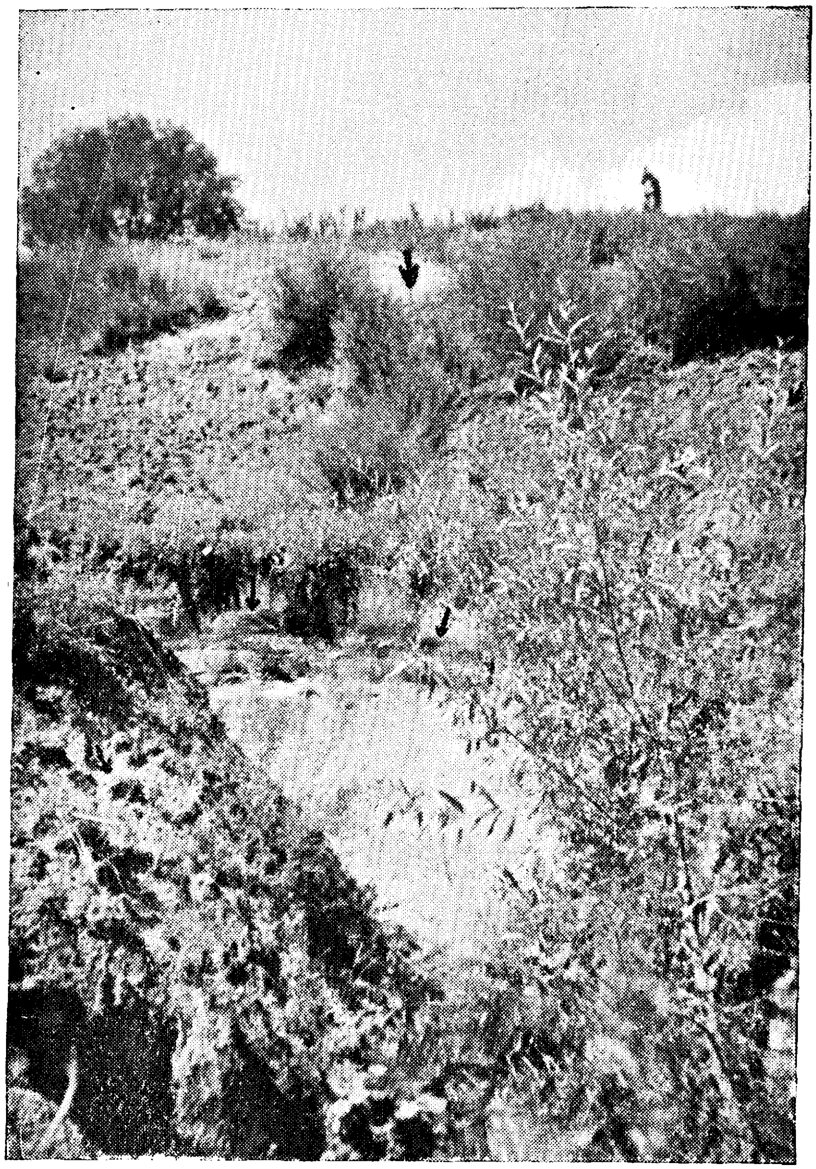

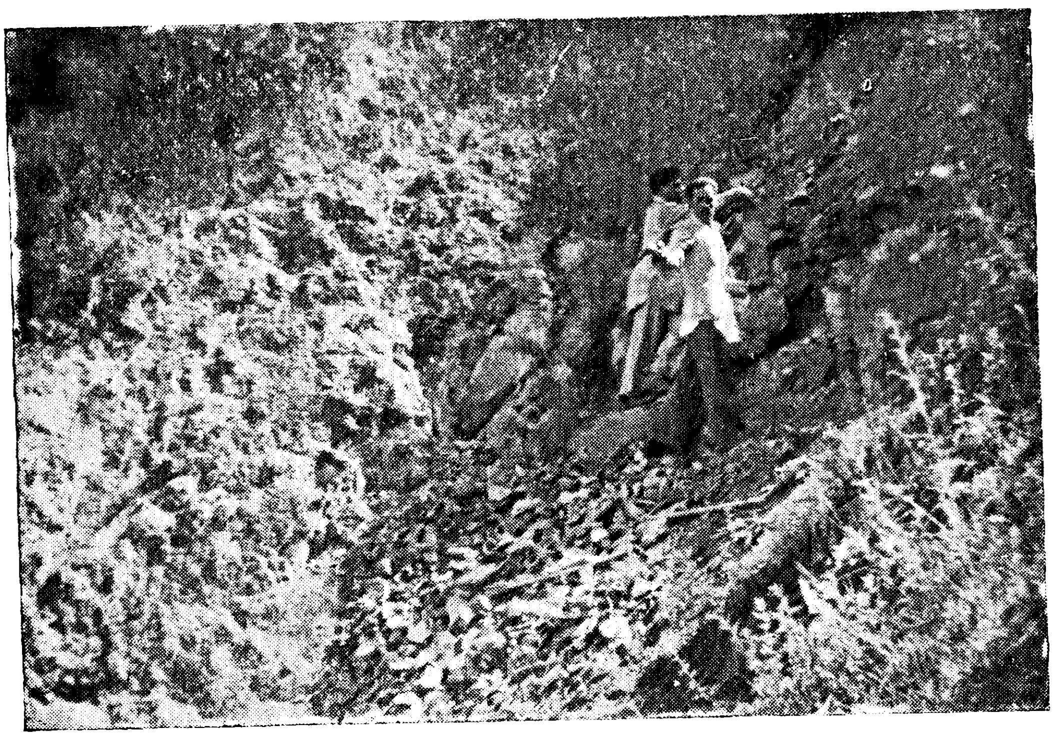

TABLE III

MODERN DISTRIBUTION OF THE FOSSIL SPECIES

The accompanying table gives the fossil distribution of the species (locality and altitude) together with elevation of their present occurrence and modern distribution in a few hill stations in the outer ranges of the north-west Himalayas. A perusal at the table will reveal that most of the species, excepting a few which are found in the inner dry valleys are restricted to the outer ranges of the Western Himalaya, however, one or two species are exclusively Eastern in their distribution; there are some Western Himalayan types, which, although not indicated in the table, extend also in the Eastern Himalaya and even further east into Assam and Burma; one species viz., **Quercus Ilex** is widely distributed in Europe and Asia. The main aim of this table is to present to the reader a contrast between the past and present distribution of the fossil species in the Kashmir Valley, and the modern distribution of the fossil types in some selected places in the outer ranges in the Western Himalayas is given to show a probable comparison between the present flora of these ranges and the past flora of Kashmir.

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(EXPLANATION OF PLATES 1-5)

Plate 1.

Fig. 1. A general view (looking south from the footpath that leads from Baramulla to **Gulmarg**) of the fossiliferous beds near the village of **Laredura**; the white patches (marked with **arrows**) in the forested hill are the **plant-bearing outcrops**; the spot 5 yielded a few badly preserved fossil leaves.

Fif. 2. A view of another fossiliferous **stratum** north-east of the main huts of Laredura; 1, 2, 3 point to the fossiliferous localities; the arrow at the base of the photograph points to the foot of the cliff.

Plate 2.

Fig. 3. A close view of **spot** No. 1 (**shown in** Fig. 2), which has yielded a large collection of well preserved fossils in situ; the irregular **bedding** of the clay and thickly laminated **layers** are seen at the spot, where the collection is in progress.

Fig. 4. A view of the Trapa-bearing **locality** (near Laredura) showing thick **strata exposed** along a small stream; the arrows point to spots, which yielded fruits of **Trapa.**

Plate 3.

Fig. 5. A view of fossiliferous strata, **near the** village of Dangarpur, exposed along a **stream,** a dry ravine and tilled fields; the **arrows point** to the fossiliferous spots.

Fig. 6. A close view of a **fossiliferous stratum** in the meadow near Ningal Nullah showing **bedding** of clays and some boulders (towards **the** upper part), which are part of probably a moraine.

Plate 4.

Fig. 7. A view of the bridge over Ningal Nullah near the village of Botapathri; the arrow points to the direction in which the fossiliferous localities lie in a grassy meadow about a furlong from the bridge.

Fig. 8. A view of Ningal Nullah locality showing plant-bearing beds (marked with arrows) under a moraine (M); the thinly laminated nature of plant-bearing clays is evident.

Plate 5.

Fig. 9. A view of another fossiliferous locality in the grassy meadow near Ningal Nullah; the dotted lines mark the level of the two fossiliferous strate, which have yielded fossils at a few spots (marked with arrows).

Fig. 10. Another fossiliferous spot in the meadow showing the nature of bedding of clays.

Marvels of the Great Indian Desert
Hospitality amongst Desert Plants

(By Chatur Bhuj Gehlot, D.D.R., Retd. Conservator Forests, Mines, &c., Jodhpur).

(Utilisible for reclamation and rejuvenation of desert into productivity—by and for Farming).

G|0473|In.—Terms of local nomenclature of the Indian desert are defined and the ecology of the desert explained.

DESERT GROWING

Locally, The Desert is called:—
'Thar' meaning "deposition (of sand) layer after layer" forming the desert.
or **"Thoti Thali"** denoting hollow or barren **land".**

These desert conditions have, for ages, been growing from bad to worse, in geological chronology, and concomittant physical metamorphosis and chemical changes;—and with them, the condition, habits, quality, productivity of its fauna and flora have been degenerating chemically biologically and economically.

NOMENCLATURE

This desert country, evidently, with the growing desert conditions, has been receiving the qualifying names in chronological order, as below:—

(1) **Murdhar:**—meaning Triloky (land of "trios" sandy undulations alluvium plains and mountains or rocky elevations).

(2) **Marudhar:**—or Marusthal meaning deadly or dreary desert region so called when the sandy desert predominated.

(3) **Marwar:—**meaning land of struggles and escapes, as at present.

Thus, of course, out of inborn hospitality and co-operation most of the plant-life, making a common cause against sand invasion and weather inclemency, have had to change the mode and rationality of life, per force or habitually to befit themselves adaptively to the changing ecology of the desert, saline and alkaline areas and rocky skeletons.

No wonder, then, its original rich flora and fauna gave way to the arid types with rare scatterings of hardy strugglers persisting, here and there, in desert or semi-desert.

EARLY OBSERVATIONS

My first impressions were received while on Leffroy's Investigations of locusts (1896-97). When, of course, the stock of plants (forest, pastoral or agricultural) had naturally to be studied in relation to its life and death struggle with the formidable enemy—the locust, besides and amidst hard and treacherous weather. Then and there, on close examination I felt, how important and compulsory is it, to keep in tact the indigenous vegetation to ensure the maintenance of balance of natural or artificial tree culture, agriculture, etc., as well as animal life for the sake of human prosperity and even existl ance, from generation to generation.

DESERT VERSUS VEGETATIONS

A struggle ceaselessly goes on between the two and the less of Vegetation, the more of desert and "vice versa" is the proven result, everywhere. I observed many points—beneficials resulting from preservation of the plant life in favour of cattle and man, and amelioration of desert conditions affecting its edaphic factors, aerial, manurial, humid, humus, water, etc., as well as rural economy and climate.

Revisiting a part of the same desert, last spring, I was struck to find the plant-life on the decrease in general, and even so in Pabuji-ka-Oran (a sacred reserve) near Kolu in the desert, in particular, during only half a century, which is woeful.

Fig. 1. P. JULIFLORA & A. Odoratissima.

Patoa-Zalim-Vilas Road, JODDPUR

Fig. 2.

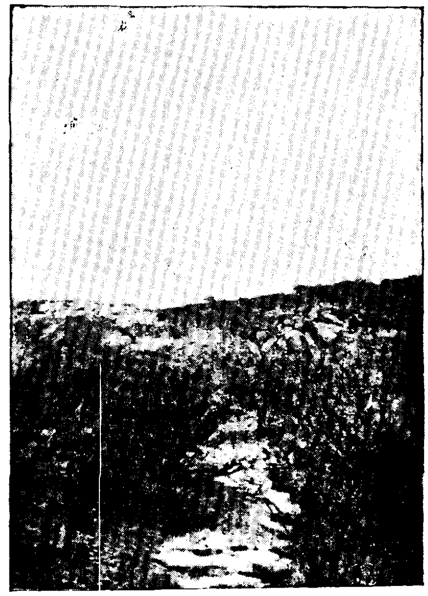

Fig. 3.

Fig. 4. P. JULIFLORA & others on Sands.

J. Rly. Line, near Zalem-Vilas, Ju.

VITAL SCIENTIFIC INTEREST
(Figures—photos Nos. 2, 3 and 4)

Bearing in mind the above facts, and continuing the observations while trying to make artificial plantations or preserving the natural vegetation, my conviction gathered strength and a vital scientific interest and value continued to become associated with it as observed in the deserts of Rajputana, Northern Central India (Gwalior-Chambal valley, Banswarra—Mahi valley, Western U.P.—Yamuna valley—Bharatpur to Jhansi and N. Gujrat—Banas and Kumari river courses).

CLUSTERS, FORMATION

Numerous examples have been observed to exist in these jungles and deserts, of plants mostly xerophytic, growing together according to certain affinities and environs. Trees shrubs, herbs and grasses grow together in groups of twos, threes, fours and more occasionally, almost peacefully and mutually aiding each other, for long enough in life, like refugees from war with constant sand invasions and rocky desert severities vide Fig. 2 and 3, Jodhpur environs. Even the independents isolated survivors assume clumpy bunched growth or spinose and bramble like and bristly armament or equippage. This habit and necessity has been taken advantage of in making arboricultural plantings in topes or groups and in double rows.

ASSOCIATES

Commonly, the following genuses and species (xerophytic) are found to make amiable associations, clusters or groups:—**Indigoferas, Ficuses, Salvadoras, Prosopises, Tamarisk, Zizyphuses, Acacias, Grewias Euphorbias, Tecomaa, Capparises, Poincianas, Melias, Colligonum, Calotropises, Aeiuas, Cassias, Carissas, Cordias, Albizzias, etc.**

It is worth noting in this connection that xerophytic species which are exceptionally drought resisting and deep water-lavel-tappers, or otherwise fitted e.g., **Prosopis spicegera, Capparis aphylla**, stand by themself forming more or less gregarious formations without needing succour and shelter. **P. spicegera** is supposed to be rich in Oxygen? (Vedas)

Hospitality of Man

Travellers, geographers, naturalists, historians, and others have written well of the people living in the desert calling them "hospitable,"—besides being recognised as hardy, industrious and simple. This is the habit or nature inculcated by environs and the food-animal or vegetable eaten and common hardships etc., experienced and opposed. The popular saying is "As is the food so is the mind." Now the cattle eat the grasses and vegetable products of the desert species which are in nature mostly simple, hardy, bountiful, co-operative, protective and beneficial, bearing products (Harvest) even in adverse conditions themselves sufferings but yielding fruits etc., *for the sake of cattle and man* out of their self-sacrificing nature (e.g. In famine certain plants like the Ker (**Capparis aphylla**) replete with hydrogen and carbohydrates? (Vedas) bear fruits, seeds, flowers, leaves, twigs, etc. as *famine foods*, fodders, honey &c., prolifically to support man and cattle so is the local popular saying:—"Kal kahe men paroonla—to 'Ker', kahe men teen var phaloonla."

Dietic and Physiological Philosophy

(Famine falls by failure of crops but the **Ker** yields three harvests of its edible products three times a year — March, July and October during famine). Man partaking of them direct or through the the same spirit of self-sacrifice, hospitality, co-operation and production towards their fellow beings as well as cattle and plants. Thus, the cycle of hospitality propagates from inert nature to man through plants and cattle. The desert cow, camel, etc. are congregatory and home-sick (bound) centrifugally-cum-centripetally, even after roaming (grazing) dozens of miles.

Preservation of Vegetable Products

Climate favouring, the preservation of all available vegetable seeds fruits etc., for use and trade in and out of season is an unavoidable necessity and profitable practice with the desert people. This sun-drying of vegetables has been invogue, since long past, at least from the time the Sandy desert buried the fertile multi-productive land. They relish these vegetables more than meat and luxurious diets confectionary and condiments.

Institution of Sacred Forests

Therefore, the desert people are wise and far sighted enough to preserve plant-life and useful animals by forming "Orans," "Rakahats," "Jors," "Shikar Khanas," "Sacred Trees," Royal Trees," "Sanctuaries" etc., out of charity or public and self-interest or religious-mindedness. This is, so to say, an ancient form of Forestry much needed and well maintained as far as possible. But the famine and scarcities, poverty and ignorance, above all the rapidly and overwhelmingly increasing and all powerful invasions of sands, drought, frost, and extremes of climate, over-exploitation, ruthless cutting, grazing, etc. coupled with no or meagre attempts at fresh afforestations, the scale is up set and the conditions are worsening.

Hospitality amongst Plants

Amusing Experiment (Fig. I)

To test the above characteristic features, habits, etc., of desert plants, and experiment was undertaken in 1914-15 in Arboriculture at Jodhpur (Paota Road) with the newcomer, Bi-furcated Prosopis Juliflora and Albizziaodoratissima which germinated and grew together like "Twins" Potted and transplanted together at the junction of the road with its branch road leading o Maharaj Zalim Vilas. Both the Species being fast growing the former being a bit faster twined like a climber round the latter. They were disentangled and led upwards, after a year or two and allowed to grow side by side the trunk shoot hemmed in between the two was, latterly, cut away. To the present day they have been so to say peacefully living together like individuals of the same kind, the former leaning more towards south west the Sunny hot side while the former grew almost straight with the crown developing more towards the opposite sides with some branches interlacing. The trunk growth and crown spread of both matching equally between themselves and fairing well comparatively with their neighbours in the same row as well as the opposite row comprising of Species of their own and Melia Indica. They measure 35 and 37 in height and A $\frac{3}{4}$' and $3\frac{1}{4}$' in girth, respectively, which is a fair growth for the period of nearly thirty years Fig. 1. Thus the struggles for the existance law has proved unharmful almost to both. This shows the natural affinity between them, both being xerophytic, more or less the former surpassingly so.

A Striking Example

A striking example has recently come to my notice, special, during the scientific investigations for dry farming potentialities in the Bikaner Desert at Ratangarh in a Secred reserve called "Bir" near the State Guest House on Sandy soil and duney sand-hills. Here, five plants of different species, all xerophytic in nature growing together peacefully for about forty years past, atleast exercising congenial hospitality towards each other making a imperceptible struggle rather healthy co-operative competition to promote the growth and protection mutually.

Family Group of Different Species

(1) The first settler above 40 years of age is decidedly Gymnosporea Montana (Kankera) —a long-lived hardy large spreading spinose shrub, self-sown on a flatened Sandy mound in a broad cutting across a duney axis made the broader and flatter by cart tracks and bridle-paths crossing it. It is light-demanding, open, light-green-sparse-foliaged, much branched (the thicker boughs supporting a open tangle of smaller branchlets spreading all sides in inter-spaces. Its roots likewise branch to all the 4 sides wide apart but by lint of "Geotropism" going downwards at an abrupt curve in search of water, giving the plant a wider deeper stable, stake, into the sandy mound top now blown out by wind forming a open cagelike structure around the base, to serve as a tree gyard for future comers, so to say. The spiny and drooping branchlets making a fence round the family group.

(2) Next probably came Tamarisk articulata (Unth Phog) at the outer skirt of the mound to eat or reduce the salt leaching from the mound. It grew tall with tufted crown of its needle-like leaves. It being a halophilous saltwort by nature kept the common bed of the group much reduced in salinity, itself attaining pole-stage beyond camel and goat reach, first through the protective crown of host No: 1, and then, when high enough bending outwards my 'Heliotropism'.

(3) The 3rd to join, probably was Salvadora persica (Khari-Jal) on the other side. It is an evergreen desert plant. It being also halophilous took up the same role of reducing excess soil salinity besides serving as a frost wind, heat-break. Being pungent the browsers don't relish it so much. It served to enlarge the family, thus, cheerfully undisturbed.

(4) About 30 years later, the under-cover gap was filled by thorny drought-resisting sand-binding undershrub—the Luceum europeaum (Moraly). Thus, a complete defensive verdore-in-aid was formed for the family group to grow and prosper despite the inclimencies of weather and inroads of sand, browsers and wind.

(5) Last, to dignify and enthrone the tiny colony or family group—well fortified and congenially and peacefully surviving all equally and lovingly embracing each other, without the harsh effect of struggle for existance appearing, —set in and became established in the centre in the of the thick roots cage above referred to,— the 'Tecoma' undulata', the king of the desert trees proudly designated the so-called "Teak of Marwar" on account of its timber properties. Its natural height growth was thus well tolerated rather accelerated by the comarades. It towers pretty high about 20 ft. from ground above and through the central combind crowns of the family members, even at a comparatively younger age (Pole-Stage).

Facts Discovered.

From the above observations, it is a clear case of "Live and let live". The following fundaments and functions of desert plants in general and

certain xerophyric species, in particular are obvious:—

1. There is a sensory affinity between certain plants of like nature and common cause more than others unlike and distant apart.
2. A susceptibility and adaptability to environs creating common ecological characteristics, by Ecosis, Invasion & Extension, physically, chemically or physiologically.
3. The law of struggle for existance and survival of the Fittest seems to be reversed or at least moderated for long in life so as to enable the Associates to prosper fairly well towards normality.
4. Their exists a trend of 'Hospitality' among plants of like-nature mutually aiding protecting each other in their own way, to combat the adverse influences or attacks of desert condition.
5. The soil humidity is preserved longer within the reach of plants roots by the net work of combined roots systems of the members of the family, which otherwise would have descended deeper down too soon owing to the rain water percolating rapidly through the porous sandy bed as in naked situations, and sporadic formations.
6. The surface and sub-surface rain water currents and contents of the soil are protected by the dense and wide spread deep crowns root-nets of the family members against rapid evaporation, erosion.
7. The fresh coverings of moving sand are held up and fixed by the wind-breaking effects of the crown cover and sand-binding power of the combined roots systems and humus formed by the members of the group.
8. The effects of dust storms hot wirls and heat-insolation are moderated by the combined crowns.

Further Research.

To scientifically gauge and study these characteristics of desert plants and the factors of Ecology, it is essential to extend the research over wider areas and diverse conditions by and under better hands and arrangements.

STATISTICAL METHODS AND EXPERIMENTAL DESIGN

Record of a talk given by Dr. K. R. NAIR

It is known to you all that the main function of the Statistical Branch is to see that the various experimental investigations conducted in the different Branches of the Forest Research Institute are laid out or planned on modern statistical lines in future and to statistically analyse the data of such experiments to assess their precision. The Branch came into existence on 1st August 1947, but no enquiry was received seeking advice on the design of experiments from any Branch until one day at the end of November I made a visit to one of the Branches and virtually 'canvassed' for some work.

Meantime, again more by personal canvassing than by the initiative of the Branches concerned, the Statistical Branch began receiving data for statistical analysis relating to experiments conducted in the recent past. This analysis work forms the main activity of the Statistical Branch at present.

The point I wish to emphasise today is that the statistician should be consulted before any experiment starts to enable him to judge whether

(i) it is designed in such a way that valid conclusions could be drawn from the resulting data.

(ii) It contains adequate number of replications to (a) get a reliable estimate of the precision of the experiment and|or (b) keep the magnitude of the precision at any desired level.

I shall presently explain the term "precision" more fully. You all know as a matter of experience that results of tests with different samples taken from the same apparently homogeneous material differ among themselves. Homogeneous material is one within which all assignable sources of variation have been under control and the variation that still exists is due to uncontrollable (hence called random) causes.

* Statistician F.R.I. at a meeting of the Research Officers of the Institute held on 22nd December 1947.

Suppose we take n units from such a homogeneous material (or universe, or population or assembly) and observe any measurable character x on each unit. The n observed values of x will differ among themselves and may be denoted by $x_1, x_2, \ldots x_N$

We calculate the arithmetic mean (A.M.) of these values denoted by $\bar{x} = \frac{1}{N}(x_1 + \cdots + x_N)$ to represent the typical value of x for this homogeneous material.

There might have been a very large (almost infinite) number N of units in the material (or universe). The n units actually observed form only a part of this universe or population of units. The A.M. $\bar{x}$ calculated is only an estimated of the unknown mean, $m = \frac{1}{N}(x_1 + \cdots + x_N)$ obtained from a sample of n observations. In practice, it is not possible to examine all the N (infinite) units and we have to be content with an estimate $\bar{x}$ of the unknown mean, m.

$\bar{x}$ will be an **unbiased** estimate of m only if the units examined are a **random** sample from the universe of N (infinite) units. By random samples, we mean that the process of selecting the n units must have been done in such a way that every one of the N units in the whole material had an equal chance (or probability) of being included in the sample.

We know $\bar{x}$ will not be identically equal to m. In fact, if we repeat the sampling process and examine another random sample of n observations, say $x'_1, x'_2, \cdots x'_N$ we will get a different A.M. $\bar{x}'$ which is not likely to be identical to $\bar{x}$. By repeating this sampling ad infinitum in this manner we can get an infinite number of different estimates of m, namely, $\bar{x}, \bar{x}', \bar{x}'', \cdots$ each being the A.M. of n observations.

The closeness of this infinite number of estimates among themselves will depend upon n and also on the variation among the N individual units of the original material. This latter variation is usually measured by the parameter σ ("Sigma") which denotes the standard deviation of x. σ is calculated from the formula $\sigma = \sqrt{[\{(N_1-M)^2+(N_2-M)^2+\cdots+(N-M)^2\} \div N]}$ Evidently $\sigma = 0$ when $x_1 = N_2 = \cdots = x_N$ i.e. in a universe which has no variation.

The variation among the estimates $\bar{x}, \bar{x}', \bar{x}'', \cdots$ is measured by their standard deviation which comes out to be $\sigma / \sqrt{N}$

The precision of a single estimate, say $\bar{x}$, is inversely proportional to its standard deviation. In other words, "Precision" of the mean of n observations (drawn at random) is proportional to $\sqrt{N} / \sigma$

It will be seen therefore that "precision" can be kept at any desired level for a given σ (that is, a given universe) if n is increased indefinitely.

You will also notice that knowledge of σ is very essential to assess the precision of the sample estimate $\bar{x}$ of m.

Without going into the theory I shall now state an important statistical inference about the probable value of m, an inference drawn from evidence supplied by the sample mean $\bar{x}$. The inference is:

"There is a 95% chance that the unknown m will lie between $\bar{x} - 1.96(\sigma/\sqrt{N})$ and $\bar{x} + 1.96(\sigma/\sqrt{N})$ the number 1.96 being arrived at from the Normal Law."

In practice, σ is unknown but an estimate of it, usually denoted S, can be obtained from the observed sample $S = \sqrt{[\{(N_1-\bar{N})^2+(N_2-\bar{N})^2+\cdots+(N_2-\bar{N})^2\} \div (N-1)]}$ $(N-1)$ is called the "number of degrees of freedom" in estimating σ from a sample of n observations. In this case an **interval** estimate for M is provided by the limits $\bar{x} \pm t(S/\sqrt{N})$ where t is a quantity whose magnitude will depend on n. If n is very small t will be large and when $N \to \infty$ $t \to 1.96$ as shown in the following table

n t (at 95% Probability)

2	12.71
3	4.30
5	2.78
10	2.26
20	2.09
30	2.05
120	1.98
∞	1.96

That part of statistical theory which led to the second interval estimate which uses only information supplied by the sample, namely and , has completely revolutionised statistical science and has brought it to the door of the experimental scientist who has often only a small number of observations from which to draw scientific inferences. It will be of interest to you to know that its discovery was made not by a mathematical statistician, but by an experimental scientist by name W. S. Gosset who was a research chemist in the famous Guinness Brewery in Dublin. Of course, realising the importance of statistical principles in the conduct of his research Mr. Gosset took the trouble of going to the University College, London and studied under the late Karl Pearson in the Galton Laboratory round about 1905. He published his classical paper on the subject in 1908 under the pseudonym of "Student".

"Student" or Gosset is not the only non-mathematician who has made significant contributions to statistical science and widened the range of its applications. In India we have Prof. P. C. Mahalanobis, who is by profession a physicist, but won the distinction of F.R.S. for his work in statistics. In America, Dr. W. A. Shewhart, himself an Engineer and scores of other non-mathematicians have contributed to the development of the subject. I would therefore appeal to you all to study statistical methods and develop a statistical bend of mind in all your research work.

In planning the design of any experiment and to decide the number of replications of each treatment (a general term used for factors introduced in the experiment for comparison) you will notice that some basic knowledge about σ is necessary to forecast the expected precision of the mean value for each treatment. For instance you may be interested to compare two different processes of wood seasoning or two different preservatives. In general, let us say, we have to compare two different treatments A and B. Let **n** sample units (timber pieces in your case) be tested for A and n units for P The (2n) sample units should be selected at random from homogeneous material. Let the mean values of the character (**M of R, or Max C. Str**) say **x** be $\bar{x}_A$ and $\bar{x}_B$. These means will differ from one another even if the treatments A and B were identical, due to sampling fluctuations. From statistical theory I again quote the rule of inference that "there is a 95% probability that the difference $\bar{x}_A - \bar{x}_B$ will lie in the interval $\pm 1.96\,\sigma\sqrt{\frac{2}{N}}$ due to sampling fluctuations only".

If there had been a real difference between the treatments A and B it should be of a magnitude exceeding 1.96 ($\sigma\sqrt{2}/N$)before it can be judged as probably real. This statistical inference which is only a probability statement is usually called "test of significance of difference between two means". The quantity 1.96 ($\sigma/\sqrt{2/N}$) is called the "critical difference" at the 5% level of significance. The 5% level indicates that we should expect to go wrong in our conclusion in 5% of cases or 1 in 20 times.

When σ is unknown, as is often the case, an estimate of it, called S , is obtained from the (2n) observations in tests A and B. The critical difference will then be $t \cdot S \cdot \sqrt{2/N}$. where t will be large if **n** is very small.

If there are more than 2 treatments (**Say k**) tests of significance between pairs of treatments can be performed. The value of **t** in the critical difference will depend upon **k x n.** If **k** is large we can proportionately reduce **n** but not below 2.

The important point to be noted is that unless the difference between the mean values for 2 treatments is greater than the critical difference. $1.96\sigma\sqrt{2/N}$ or $t.S.\sqrt{\frac{2}{N}}$ (as the case may be) it will have to be declared non-existent. The research workers' aim should be to keep the variation in his material as much under control as possible so that σ or S (as the case may be) will be a minimum. This is often possible by stratifying the material into more homogeneous groups or strata. He should then try to keep the number of replications, **n**, as large as is convenient.

Very often, a research worker wishes to study the effect of varying more than one factor at the same time. Thus, in manurial experiments in agriculture, a common problem for investigation is to study the effect of nitrogen in the presence or absence of either phosphate or potash or both. Prof. R. A. Fisher, the well known authority

and founder of the theory of "Design of Experiments" introduced the technique of "factorial experiments" for such multi-factor investigations.

Taking an example from Forest Research problems, I recently came across the results of some experiments where a factor A (say 'pressure') was tried at different levels a_1, a_2, a_3, a_4 keeping a second factor B (say 'temperature'- constant at b_1. A second series of tests were made varying B into levels b_1, b_2, b_3, but keeping A at a_1. It did not strike the research worker concerned that there was a common treatment $(a_1 b_1)$ in the two series of tests and that the results for this treatment obtained in the two experiments should more or less tally. On examination I found that they differed widely. The number of replications of each treatment was not the same, in some cases it was I (i.e. no replication) and in others 2. It was not possible to assess the precision of the results and I would consider the whole experiment a failure. This is a typical case illustrating Prof. Fisher's view that if a statistician is consulted at the end and not in the beginning of an experiment he will very often be able to diagnose what the experiment "died of"

Instead of doing 2 different experiments first varying factor A and the second varying factor B., modern methods would suggest a single experiment with all the 4 x 3 combinations of factors A and B.

	a_1	a_2	a_3	a_4
b	$a_1 b_1$	$a_2 b_1$	$a_3 b_1$	$a_4 b_1$
b_2	$a\ b_2$	$a_2 b_2$	$a_3 b_2$	$a_4 b_2$
b_3	$a\ b_3$	$a_2 b_3$	$a_3 b_3$	$a_4 b_3$

giving 12 treatments in all. With a minimum of 2 tests per treatment you will get an estimate S of σ with 12 degrees of freedom and the value of t in the critical difference will be 2.18. Of course, the more the number of replications the merrier the Statistician will be.

The factorial experiment has many advantages. You can study whether the effect of varying A when B is kept at b_1, is same as the effect of varying it when B is at b_2 or b_3. If these effects are not the same, that points to the existence of an "interaction" between the two factors A and B, and serves as a warning against drawing conclusions about $a_1 a_2 a_3 a_4$ when B is kept fixed at b_1, b_2 or b_3 only or drawing conclusions about $b_1, b_2 b_3$ when A is at $a_1\ a_2\ a_3\ a_4$

It is in planning such factorial and even simpler experiments that the Statistical Branch could be made full use of by the other Branches. As I have already said, any prior knowledge of σ from any homogeneous data already available will be of great assistance in deciding about the number of replications. The Branches may send any such basic data to the Statistical Branch for estimating σ

Even in routine tests of physical and mechanical properties, of timber, plywood etc. it is a sound procedure to calculate, besides the mean, the variability of the data. If the calculation of standard deviation is too time-consuming for routine work there are much simpler alternative measures of variability, the prominent of which is the 'Range measured by difference between the largest and smallest observation in the simple. Such estimates of variability for data collected at frequent and regular intervals will often help us to see whether the tests are being made under proper "control".

I have no time to speak about "Quality control" technique in mechanical and engineering tests and its use in standards specifications. Dr. W. A. Shewhart, the founder of this technique is expected to pay a visit to the Institute during his stay in this country and you will, I hope, have opportunities of hearing from him on this subject.

Resolutions of the Central Advisory Board on Forest Utilization March, 1948.

Wood Technology Branch

Resolution—1.

Resolved that the compilation of a book by Dr. K. A. Chowdhury on Indian timbers is of great immediate importance and that the work should be taken in hand without delay. The book should be arranged according to families, various mechanical and physical properties, durability, seasoning qualities, including notes of Entomological and Mycological interest and uses of any minor forest products.

Dr. Chowdhury should collect the necessary information from other workers both in the Institute and outside and give this work the highest priority.

Resolution—2.

Resolved that the preparation of keys for the identification of commercial timbers of various Provinces be approved and that in addition to keys for Bengal and Assam commercial timbers, a key for the Andaman timbers should also be taken in hand as an item of the highest priority.

Resolution—3.

Resolved that the investigation on the suitability of Indian timbers for the production of cellulose suggested by the Cellulose Research Committee of the Council of Scientific and Industrial Research, New Delhi, is of fundamental importance and should be actively pursued by the Wood Technologist in collaboration with the Cellulose and Paper Branch of the Institute and that the Council of Scientific and Industrial Research should provide whatever assistance is necessary for the conduct of the investigation.

Resolution—4.

Resolved that the investigation on the anatomical structure of the glue bond is of fundamental interest to the plywood and wood-working industries and that it should be carried out with the highest priority in collaboration with Composite Wood and Wood Preservation Branch.

Resolution—5.

Resolved that all items of research work proposed for the next five years for the Wood Technology Branch be approved and that the following order of priority be adopted:—

Priority 'A'—Item 6 (a): Investigation of timbers used for ship-building—Red Cutch.
Item 7 (b): Resin and gum tapping—**Shorea robusta** (Sal) in U.P.

Priority 'B'—Item 1 (a): Anatomical investigation of Indian species **Picea morinda** (Spruce) and **Abies pindrow** (fir) for finding out their suitability for air-craft material.
Item 3: Growth studies in Indian forest trees.
Item 6 (b): Timbers suitable for (1) ship-building and (2) boat building; in collaboration with other branches.
Item 7 (a): Resin and gum tapping—**Sterculia urens** (Karar) in U.P., C.P., and Bihar.
Item 7 (c): Resin and gum tapping—**Pterocarpus marsupium** (Bijasal) in Bihar.

Priority 'C'—All other items in the proposed programme.

Resolution—6.

The Board was of the opinion that it might be of advantage if items of work for which facilities did not exist in the Forest Research Institute, particularly those relating to the fundamental sphere, were entrusted (on a collaborative basis) to research workers in Universities and outside research laboratories.

WOOD SEASONING BRANCH

Resolution—7

While noting with disappointment that the seasoning kilns and sawmills installed during the war by the Department of Supply, Government of India, at various places in the country had been sold out and dismantled in the interest of national economy, resolved that such seasoning plants as were built during the war should be replaced as soon as possible and that new seasoning and treating plants should be set up at most of the important Forest Department Timber Depots, and that these seasoning kilns and treating plants should be run by organisations in which both the Government and the trade were adequately represented.

Resolution—8

Resolved that steps be taken by Central and Provincial Governments to further the use of properly seasoned and treated timber and with this object in view to set up various Inspectorates to ensure that the standards set up by the Indian Standards Institution and by the Military Department are enforced in practice. The Board would stress the need for steps to ensure that all Government Departments, such as Military Units, Railways, Telegraphs, Electricity Undertakings, M.E.S., P.W.D., Ship-building and various organized large scale timber users used seasoned and treated timber.

Resolution—9

Resolved that work on industrial investigations should be actively pursued. For the tests on seasoning and suitability of Indian woods for cotton, woollen, silk and jute mill accessories, the collaboration of the Composite Wood and Wood Preservation Branch should be invited, particularly for the development of composite wood products to serve these requirements.

The suitability of Indian timbers including treatment of various woods with waxes, dyes and other chemicals for the manufacture of pencils should be urgently investigated. This investigation should be continued in collaboration with Wood Working and Timber Mechanics Branch.

Work on the suitability of Indian timbers for the manufacture of battery separators and their chemical treatment should be completed as early

as possible in collaboration with Wood Working and Timber Mechanics Branch. All these three items should be given the highest priority.

Resolution—10

The Board approved of the programme of work as put up by the Wood Seasoning Branch allotting the following priorities:—

Priority 'A'—Item 2 (e) Shrinkage retarding treatment. The treatment to be done by the Composite Wood and Wood Preservation Branch and the testing by the Wood Seasoning Branch.

Item 3: Natural seasoning of Indian timbers. Under this item the Sub-Committee recommended that accelerated natural seasoning of timber by forced draft created by a windmill should be studied. The collaboration of the Entomology Branch should be invited.

Item 4: Seasoning of sleepers. New species should be tested.

Item 5(c): Study of smoke type of kilns for seasoning of wood.

Item 5 (e): Seasoning of veneers and conditioning of plywood.

Item 7: Study of steam bending properties of Indian woods.

Priority 'B'—Item 1(a): Movement of moisture in wood.

Item 2(a): Shrinkage, swelling, density, variation, and moisture equilibrium of wood at various relative humidities.

Item 5(a): Study of kiln drying behaviour of Indian woods.

Item 5(b): Study of rapid kiln drying behaviour of light hardwoods suitable for packing cases.

Priority 'C'—The rest of the programme.

Statistical Branch.

Resolution—11.

The Board welcomed the introduction of statistical methods in the planning of experiments and considers it desirable that the Statistician should familiarise himself with the general technique of investigations in the different branches of the Institute in which statistical planning would be of use and that the various Research Officers in the Institute should acquaint themselves with the broad principles of statistical methods.

Timber Testing Section of the Wood Working and Timber Mechanics Branch.

Resolution—12.

Resolved that the investigation on the design of wooden towers for electric power transmission was of great urgency and that the work should be given immediate attention. In this connection the assembly of bamboos to serve as poles for telephone lines and other similar uses should also be investigated.

Resolution—13.

Resolved that the testing of laminated beams was of immediate economic importance and that the work should be given the highest priority.

Resolution—14.

Resolved that the selection of a suitable Indian timber which should be common and readily available for glue adhesion tests should be taken in hand immediately. This work would require collaboration of Composite Wood & Wood Preservation Branch, which will supply the necessary glues and of the Wood Technology Branch with regard to anatomical work.

Entomology Branch.

Resolution—15.

With reference to item 9, examination of utility of insecticides, resolved that in addition to DDT and Gammexane, copper napthtehnate and Penta-chloro-phenol should be investigated. It would be highly desirable to study indigenously produced insecticides, preferably those which are soluble in cheap solvents. This work should be done in collaboration with Chemistry and Minor Forest Products and Composite Wood & Wood Preservatin Branches.

Resolution—16.

The programme of the Entomology Branch as far as it affected utilization problems was considered and the following priorities were recommended:—

Priority 'A'—Item 2(a): Experiments on the high girdling of salai.

Item 4: Protection of plywood against borer attack. Research should be carried out in collaboration with Composite Wood and Wood Preservation Branch.

Priority 'B'—Item 1(b): Investigation of sawn planks of **Bosewellia serrata** from insect borers.

Item 2(c): A new item to be taken in hand, namely the effect of poison girdling at base of **Boswellia serrata** against insect attack.

Item 3: Protection of newly felled timber from borer damage.

Priority 'C'—The rest of the programme.

Composite Wood & Wood Preservation Branch.

Resolution—17.

(a) Resolved that in the interests of the nation's economy treated timber should be used in place of steel and concrete wherever possible and therefore recommended that immediate steps should be taken to collect all information with regard to both availability and requirements of timber for various uses viz., railway sleepers, poles, bridge timbers, house construction, hydraulic pipes etc. As far as present knowledge went, the cost of treated timber structures would generally compare favourably with steel structures.

(b) Resolved that in order to make the use of [illegible] more extensive, it would be imperative to instal [illegible] preservation plants in several centres for treating timber. The treatment should not be confined to one process or preservative but should depend on the use to which the treated timber would be put and the availability of raw materials in the country.

(c) Resolved that the Government should be requested to give a lead by using treated timber more extensively. To ensure that treatment of timber is done satisfactorily before supply to the Government Departments, the industries and the public, it would be essential that trained staff was maintained at the Institute for loan to the agencies running plants as and when required.

(d) The Board was of opinion that the timber trade was not sufficiently well organized to be entrusted by itself with the development of wood preservation; the primary object of the scheme was to supply treated timber for Government services, and both saw-mills and seasoning plants would form part of the equipment at each centre. The Board therefore recommended that an organization in which both the trade and Government were represented should be set to develop the production and utilisation of treated timber in a systematic way.

(e) Resolved that the proposal would require very careful examination on the technical, administrative and financial sides by a small Committee to be appointed to evolve definite proposals. The Committee should include representatives from the Ministries of Agriculture, Industries & Supplies, the Technical Power Board and the trade.

Resolution—18.

The Board noted with satisfaction that a complete **plywood plant** was being installed in the Institute. Resolved that in addition **pilot plants** for impregnation with recognised resins, production of plywood tubes and laminates (for textiles, electrical, sports and other industries) should also be installed as preliminary experiments had been carried out with encouraging results.

Resolution—19.

Resolved that figures for the quantity of semul available and the quantities at present used by match factories etc., should be collected. Similar data should also be collected for alternative species, viz., **Evodia, Ailanthus** etc., which were found suitable; and the match factories should be encouraged to use these species. The Provincial Forest Departments might also be requested to increase production of semul as there is a great demand for semul both as timber and as kapok.

Resolution—20.

The Board further recommended that high priority should be given to devising ways and means for increasing the mechanical life of railway sleepers by the use of composite wood products.

Resolution—21.

Resolved that the programme of the Branch be approved subject to the order of priority of items as below:—

Items of high priority.

Item 6(a): To continue the investigation on evolving optimum conditions of preservative treatment for important Indian timbers.

Item 12(a): Development of glue formulae for plywood. *This would include work on Indian* casein, vegetable caseins, synthetic resin glues from indigenous materials, and glues from forest products.

Item 13: Development and|or study of accelerated methods of setting of adhesives, production of aircraft plywood, laminated wood, moulded plywood, composite wood etc.

Item 7: To investigate simple, cheap and efficient methods of preservative treatment applicable to hutting timbers, packing case timbers, and bamboos etc. This would include protection against sapstain, mould, decay and insect damage.

Item 2(a): An investigation of the cause of erratic penetration of Ascu and other preservatives in chir (**Pinus longifolia**) and creosote and other oil preservatives including the following:—

(a) Examination of old creosoted timbers.
(b) Studies on sludge formation in Indian creosotes.
(c) Changes taking place during service, (evaporation, leaching, oxidation etc.)
(d) Factors affecting permanence.
(e) The blanketing effect of fuel oils.

(f) Toxicity tests on Indian creosotes and creosote mixtures.

Item 4(b): To investigate the possiblity of developing:—

(i) A combined antiseptic and fire retardant composition;

(ii) A combined moisture retardant and antiseptic composition; and

(iii) A combined antiseptic, moisture retardant and fire retardant composition.

Item 6(b): To continue the investigations on the treatment of the more refractory Indian timbers by the incision method. If an incising machine was purchased during the period tests on the following species would be done:—

Chaplash, (**Artocarpus chaplasha**) Assam.
(**Eugenia gardneri**) Madras.
(**Lagerstroemia tomentosa**) Madras.
(**Schima wallichii**) Assam.

Item 9(b): Work on processes and treatments (impregnation with synthetic resins etc.) which impart special properties to wood for textile mill requirements and other industries for which suitable woods for special purposes are required.

(c): Work on processes and treatments (impregnation with synthetic resins etc.) which impart special properties to wood for rifle parts. Tool handles for rifle parts. Tool handles and other (war) requirements.

Item10(b): Study of the various physical properties of plywood, composite wood and compreg.

Item11: Wood improvement.

Item 14: Utilization of waste veneer.

Resolution—22.

The Board noted with regret that valuable work on the use of composite wood of textile auxiliaries, railway work etc., was held up for want of staff.

Wood Working Section.

Resolution—23.

Resolved that in order to make the best use of timber and to assist in the training of technicians in the saw-milling industry the sawmills and wood workshops should be modernised.

Resolution—24.

Resolved that the programme be generally approved and that high priority be given to:—

Item 3(a): Tests on seasoning and suitability of Indian woods for cotton, silk, wollen and jute mill accessories such as shuttles, bobbins, picker arms etc., (in co-operation with Seasoning Branch).

(b) Rifle furniture.

Cellulose & Paper Branch.

Resolution—25.

While endorsing the recommendations of the Experts Committee on the reorganisation scheme of the Cellulose and Paper Branch as approved by the Advisory Committee of the Indian Paper Industry, resolved that the programme for the current year as passed by the Advisory Committee of the Indian Paper Industry be approved and that high priority be given to work on water proof paper (bitumenised paper).

Chemistry & Minor Forest Products Branch.

Resolution—26.

Resolved that, in view of their great economic importance, attention should be focussed during the first year on the following items namely:—

(a) **Tamarind seed:** Whereas as a result of the investigations carried out, a promising industry had been established, utilizing large quanties of tamarind seed for **producing sizing material,** (whereby already over a million maunds of foodgrains were being saved annually with the possibility of still further saving) and also in view of its other potentialities, the investigation of this hitherto neglected product should be continued.

(b) **Camphor-yielding ocimum:** Whereas India had practically no source for the manufacture of synthetic or natural camphor, and a quickgrowing species of **Ocimum,** rich in camphor, had been discovered, its cultivation and investigation should be continued.

(c) **Survey:** Whereas a large diversity of minor forest products already formed raw materials for a number of industries and for export and that some of these were being ousted from the market and some others threatened with a dwindling trade because of lack or insufficiency of knowledge about their distribution, existing methods of collection, extent of existing trade, scope of further demand, adulterations, grading etc., a complete survey was highly desirable. Such a survey would take a long time, and a beginning should be made from amongst the 22 commodities listed below:—

DRUGS.

(1) Artemisia (**Artemisia maritima Linn.** forma **rubricaule** Badhwar and **A. brevifolia** Wall.)
(2) Ephedra (**Ephedra** spp.)
(3) Sarpagandha roots (**Rauwolfia serpentina Benth**).

Tanning materials.

(4) Avaram bark (**Cassia auriculata Linn.**)
(5) Babul bark (**Acacia arabica** (lam.) Wild.)
(6) Myrobalan (**Terminalia chebula Retz.**)

Gums, mucilages and pectins.

(7) Tamarind seed (Tamarindus indica Linn.)
(8) Karyaa gum (Sterculia urens Roxb.)
(9) Kino gum (Pterocarpus marsupium Roxb.)
(10) Ghatti gum (Anogeissus latifolia Wall.)

Resins.

(11) Bhilawa nut (Semecarpus anacardium Linn. f., and S. travancorica Bedd.)

Essential Oils.

(12) Cinnamom-leaf oil and bark (Cinnamomum zeylanicum Breyn.)
(13) Citronella oil (Cymbopogon nardus Rendle).
(14) Rosha or palmarosa oil (Cymbopogon nardus Rendle).
(14) Rosha or palmarosa oil (Cymbopogon martini stapf, var. motia).
(15) Gingergrass oil (Cymbopogon martini Stapf, var. Sofia.)
(16) Lemongrass oil (Cymbopogon citratus Stapf and other spp.)

Fibres & flosses.

(17) India kapok (Bombax malabaricum DC.)
(18) Kitool fibre (Caryota urens Linn.)

Oils and Fats.

(19) Lauric acid (from seeds of Lauraceae family).
(20) Illipe nuts (Madhuca butyracea (Roxb.) Macbride (Bassia butyracea Roxb.)
(21) Piney tallow (Vateria indica Linn.)
(22) Kokum butter (Garcinia morella Desr.)

(d) **Kuth and juniper:** In view of the importance of essential oils from kuth (Saussurea lappa C.B. Clarke) and juniper (Juniperus species) the work already in progress should be continued.

(e) **Kamala seed oil, marking nut and Boswellia resin:** In view of the fact that the seeds of Mallotus philippinensis Muell., hitherto a waste product of kamala trade, offer a good source of a quick-drying oil of the type of tung oil, the work on this should be continued. Moreover, the work on the resin and oil of the fruits of Semecarpus travancorica Bedd., which are similar to bhilawa nut (S. anacardium Linn.F.), should be continued with a view to supplementing the supplies of the latter. In addition to these, work on Boswellia serrata Roxb., now in hand, should be completed.

(f) **Soil stabilization:** In view of the promising results so far obtained from a preliminary work on certain minor forest products in bringing about the stabilisation of soil, further work on this useful line would prove of great interest.

Resolution—27.

Resolved that the Board should record its appreciation of the importance of the monograph under publication on the poisonous plants, aromatic plants and tanning materials, and was of the opinion that these would constitute valuable contributions to the advancement of knowledge on the subjects.

Resolution—28.

Resolved that subject to the above, the plan of work of the Chemistry & Minor Forest Products Branch for the next five years, be accepted.

Publicity and Liasion Branch

Resolution—29.

Resolved that in view of the increasing volume and importance of publicity and pubilc relations work, it is necessary to have a whole-time officer with the designation of Director of Public Relations who should have an Assistant Director to assist him. The post of the Director should be held by a suitable Forest Officer and that of the Assistant Director should be held preferably by a journalist with scientific background.

Resolution—30.

Recognising the need for making improved arrangements for the printing and issue of the publications of the Forest Research Institute, resolved to recommend that this could best be arranged by an expansion of the scope of the Press attached to the Surveys of India, with specific arrangements for a part of the capacity of the Survey of India Press to be set apart for work from the Forest Research Institute.

Resolution—31

Resolved that it was necessary for organised industrial show rooms to be set up at all important centres in India for the display of products utilising timber and other forest produce on a commercial scale. These should be organised with the co-operation of Chambers of Commerce or other public bodies wherever possible.

Resolution—32.

Resolved that there should be greater uniformity of production of the publications of the Institute.

Resolution—33.

The Board noted that the present arrangements for press publicity were satisfactory, but recommended that attempts should be made to bring more of the various activities of the Institute to the notice of the Press Information Bureau. The usefulness of distributing technical publications to the press through the Manager of Publications might be re-examined. The better course would probably be to prepare summaries of such publications in non-technical language and then distribute them to the Press.

Resolution—34.

Resolved that it was necessary to take an effective part in all exhibitions which were an important means of publicity. Sets of exhibits should be available for such exhibitions and the specific subjects, the training to last not more than 6 weeks at fixed periods of the year.

Resolution—35.

Resolved to make proposals for holding extension courses for personnel from industries on specific subjects, the training to last not more than 6 weeks at fixed periods of the year.

Resolution—36.

Resolved to recommend that the Directorate should be provided with a cine camera, to take motion pictures of important processes. Whether the Photographic Section of the Institute could more usefully be under the charge of this Directorate might be examined by the President.

Resolution—37.

While considering that posters were not likely to serve much useful purpose in connection with the Research Institute's work, resolved that publicity through pamphlets was necessary and this should be in the form of small size pamphlets on individual subjects, written in simple and non-technical language, and not in the form of publications for the whole Institute.

Resolution—38.

Resolved that the five year programme of work proposed be generally approved consistent with the above resolutions.

GENERAL

Resolution—39.

Resolved that in order to carry out this 5-year plan of work of the Institute successfully, immediate steps should be taken by the Government of India not only to fill all the vacant posts according to the reorganisation scheme of the Institute but also provide additional staff, wherever necessary.

Resolution—40.

Resolved that a suitably staffed and adequately equipped Mechanical Engineering Organization was an urgent necessity, for maintenance in a proper state of repair of all the machinery and equipment in the Institute and especially for erecting the variety of new machinery now on order.

The Foresters Fight Against Drought in Afforestation Work

By A. Khan with comments by Dr. R. M. Gorrie.

G|27|Gn. G|1213|Gn. G|1215|As:—Drought is one of the major obstacles in afforestation work. Temperature has an overall control on the effective amount of rainfall for a region. Characterisation of drought is only indicated with certainty by the actual response of vegetation.

Contour trenching, contour ridging, subsoiling, clean following, water spreading are suggested for water conservation. The choice of species to be planted must be adapted suitably, the density of seeding controlled, seeding should be timely, presowing treatments of seed should be the rule, and weeding with soil working should be the routine.

The origin of seed is of importance as in the case of ash. Hardening to drought by alternate soaking and drying of seed is reported for agricultural crops and opens a good line for discovery.

Drought resistance of plants can be increased by regulating moisture supply in the nursery. Excessive nitrogen supply decreases drought resistance and phosphatic manures increase it. Graded planting stock is also more successful.

Introduction. The growing of new forest Crops is one of most important and fundamental duties of a forester and in this task drought is his major obstacle over a very great part of the earth's surface. It is estimated that approximately 25 percent of the land surface of the world has a rainfall effectiveness and temperature conditions when drought is a direct menace to successful plant growth. Besides this there are vast areas of land in the predominantly humid and sub-humid zones when partial drought conditions prevail either because of faulty rainfall distribution or adverse soil conditions which do not allow full storage and utilization of the high precipitation. It is not uncommon to hear of complaints about drought damage from areas which fall outside the main arid zone and are normally considered high rainfall areas. The

main cause of drought damage here is not the total precipitation as many dry areas will find it ample if not excessive. The real trouble here is the deviation from the normal precipitation to which the soil structure, texture, drainage conditions and plant growth have got adapted and find difficult to adjust if an occasional voilent variation occurs. It is thus obvious that though the drought is a constant headache to the foresters of arid and semi-arid areas, it is also a cause of worry in comparatively moist areas as well.

Drought:—The main characteristic of the countries subject to drought is their periodic aridity. Now aridity while a matter of rainfall, may be qualified by a number of other circumstances which may serve to mitigate or increase it. These factors may be grouped as follows:—

1. Temperature. In a hot climate 30" rainfall may not be enough to remove the drought danger but in a cool climate this may be a fair security. In Canada and Siberia 10" to 15" rainfall nourishes good forest growth but in tropical countries this gives poor response.

2. Nature of soil and drainage. Impervious sub-soil with no loss by downward percolation will need lower rain to maintain adequate soil moisture as compared to thirsty porous soil with free drainage.*

3. **Seasonal distribution and intensity of rainfall:**—

There is a vast difference between seasonal rainfall received in thunder showers and evenly distributed rainfall throughout the year and received in a gentle drizzle.

Drought Periods:—From the point of view of the forester frequency and duration of drought period (i.e. periods with no precipitation or insufficient precipitation to influence soil moisture) is of great importance. The duration to which a period must attain before being considered a drought is a matter of arbitrary selection and will vary with species, age of plants, soil, aspect, temperature, time of year etc. Further the effect of drought is cumulative and 10 weeks drought prolonged for another 2 weeks may cause double harm. Due to the complexity of all these factors it is therefore not possible to suggest any particular duration of rainless period as drought. The surest test in this connection is the growth condition of plants which at once tells about the moisture deficiency in soil.

Drought Fighting practices:—

Moisture conservation: In our fight against drought water is the over all limiting factor and afforestation practices must on necessity, centre round moisture conservation. These practices can be divided into two main groups viz., (i) Maximum storage of water in the soil in a form available to plants, (ii) Efficient utilization of water by plants.

Storage of water:—Runoff accounts for a great loss and particularly in hard-baked, bare, sloping areas with rainfall of cloudburst intensity. It is the unanimous experience in all the countries which have to face sever droughts in their afforestation work that the success or failure depends on how far runoff losses have been reduced and reserve of soil moisture built up. Following are some of the important methods followed in various countries depending on the topography, soil conditions, rainfall and labour conditions.

Contour trenching:—Contour trenching has been found to be the most effective, easy and popular method of reducing runoff and conserving moisture for the use of plants. The usual pattern consists of interrupted trenches of 5' to 15' length and 1' to 2' depth and width. Some people favour continuous contour trenches of greater depth and width, say upto 3' feet but for afforestation work concensus of opinion is in favour of interrupted and staggered trenches. In the Punjab usual practice is to have 10 x 1 x 1 trenches at the rate of about 250 per acre. In Nigeria, Palestine and Cyprus where planting is more common than direct seeding, crescent shaped trenches have been dug as these are more efficient in concentrating the water supply for one plant in the centre of each trench.

The efficiency of contour trenches in controlling runoff can be judged from the result of a Punjab experiment where no run off was noticed from a trenched area after 2.3" of rainfall received in a thunderstorm during 3 hours. The adjoining untrenched areas yielded runoff almost immediately after the break of rain and practically lost the whole of the rainfall. Benefits of trenches to the plants are immense as even a light shower of 1|2 inch will make available for growth about 40 to 60 gallons of water.

Contour ridging:—Contour ridging is a very efficient and widely used method of conserving moisture in comparatively easy slopes. In America this work is done over extensive areas by specially designed machines. In India the practice has been in use for hundreds of years in Agriculture but in recent years its use has also been made in afforestation of dry areas in Bom-

* I am not sure that this follows, because run-off will be increased by impervious substratum.—R. M. GOURIE.

bay and Punjab. Work is done either by hand or bullock drawn impliments. The usual height is 2 to 3 feet with 4' to 6' base and 2 feet top. The cross distance between the ridges varies from 50' to 150' depending on the slope of the ground, the principle being that top of the lower ridge should be a little higher than the base of the upper one.

Subsoiling:—The use of subsoiling methods in afforestation work for the purpose of preventing runoff and storing water is comparatively a recent development. The method consists of loosening the subsoil (not turning it over) in a land 8 to 10 inches wide and about 12 inches deep. A packing device is attached behind the latter * (What? R.M.G.) to avoid excessive looseness and subsequent drying out. Subsoiling is done in parallel lines usually 8' apart, along which trees are planted.

The result of the work in the problem *(? R.M.G.) areas of the great plain region of America has shown that subsoiling increased average survival of the trees by 30 per cent., height growth was marked by greater (i.e. 't'o 1' greater at the end of the growing season) and vigour generally better than that of trees in unsubsoiled lines. The secret of success in subsoling lies in the underground storage of moisture which is readily available to the roots. Another advantage of far reaching consequence in subsoling is the development of wider, deeper and stronger root system which favourably equips the plants to withstand future adverse conditions.

Absorptive condition of surface soil:—Work has been in America and Australia on the cultivation of soil prior to planting to create conditions favourable for thorough absorption of rainfall and reduction in runoff. Results with pine planting have been very satisfactory in Australia and an almost complete 'take' has been achieved even in some of the very difficult areas. In Lake States 10 to 20 percent higher survival has been reported with ponderosa pine in the drougty sites. In parts of Planins region even the common agricultural practice of clean fallowing** to build up moisture reserve has been followed prior to planting of the shelterbelts. It was actually seen that this gave 9" of water in top 8 feet of soil as compared with only 0.3" in grassland and 2.3" in wheatland.

Water spreading:—This is another ancient agricultural practice used for growing food crops and improving pastures in almost all the arid countries in one form or another. The system has particularly been perfected in parts of America and India. This actually goes a step further than merely preventing runoff as here the water coming from other areas is spread over the land by a system of simple diverting devices. So far very little use has been made of this method in forestry but it is considered to be full of promise. Considerable good would result to the establishment of seedling in areas where by rather simple structures flood water could be diverted on to desert or semi-desert land nearby.

Efficient utilization of water by plants:—It makes little difference how much water is stored in the soil, unless it is used efficiently by the forest seedlings. Following are the factors that influence the efficiency with which water can be removed from the soil:—

Adapted Species:—The choice of species adapted to use the limited moisture resources in the most economical manner should be most important consideration. In this connection particular attention should be paid to the deep rooting habit, capacity to reduce transpiration through such devices as thick hairy leaves, scanty leaf area etc. Some really drought resisting species have the capacity to endure in dry air and sunshine, foliage temperature above that of the air and this enables them to reduce transpiration and evaporation losses. Such unique characteristics are worthy of consideration in the choice of species.

Density of seeding:—Rate of seeding is one of the effective ways to influence the efficiency of water utilization. Under arid conditions a thin uniform stand of seedlings free of weed competition is usually most successful. It is a common practice in forestry and particularly with cheap seed species to use rather excessive seed rate as an insurance against bad seed and casualties. This should be avoided as far as possible but if heavy seed rate has been used, then proper spacing should be carried out at the earliest possible time so that the share of moisture of unwanted seedlings becomes available to the remaining ones and carries them through the danger period.

Date of seedling:—The optimum date of seeding is the most important point in utilizing the

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Any particular soil conditions where subsoiling is valuable?

full growing season. Seeding should be carried out (why not before?) as soon as the soil moisture conditions become favourable for germination and growth. Early seeding will enable the plants to have a good start, put on sufficient root and shoot growth and become sturdy to withstand drought periods. Delay in seeding always results in poorly developed seedlings which succumb to the very first drought.

Presowing treatment of seed to get quick germination is another method aimed to utilize the growing season to the full and should be used with all the species that will respond to it. Slow generation is a common defect of most of the arid species and presowing treatment to hasten the germination should be a regular feature of the afforestation work in areas with short rainy season. Several methods such as cold water treatment, hot water treatment, alternate wetting and drying, chemical treatment, freezing, stratification, scarification, passing through animal stomach etc. have been found effective but the best method should be worked out locally for each species.

The question of optimum time applies with equal force to planting but this work should be carried out only when soil has become thoroughly moist upto root depth so that tender roots do not find their new home inhospitable at the very start. *

Freedom from weed competition:—It does little good to plants at optimum spacing if weeds are allowed to consume the water stored up in the soil. Sometime to a casual observer the weeds in dry areas do not appear to be aggressive and harmful when judged from their above ground development. But in actual practice it has been seen that most of these have a very wide and well developed root system and rob the forest seedlings of a great portion of soil moisture. Root system of grasses is particularly bad in this respect.

The only way to eliminate this severe drain on the limited moisture supply available for the forest plants is to adopt weeding as a regular feature till plants are fully established.

The weeding practice of dry areas has however, got to go a step further than the ordinary method of mere cutting away commonly used in moist areas as this does not eliminate root competition. Soil working must be combined with weed removal if satisfactory results are to be obtained. There is vast experimental evidance in favour of weeding and soil working or hoeing from all dry countries of the world. Comparative study has shown everywhere that in unweeded areas heavy mortality of seedlings occurs due to moisture deficiency caused by weeds. Experiments have shown that mere clipping away of weeds stands very poor comparison with thorough development. Hoed seedlings had 6.5 feet root length with 4.5' lateral, development against 1.7 hoeing. In the limited space at my disposal it is not possible to present all the experimental evidence in support of hoeing but results of one of the latest experiments in America are given as an example. At the end of the third year after planting there was only 31% mortality in weeding and hoeing against 62% in clipping and 92% in control. Beneficial effects of hoeing were not only confined to high survival of the plants but then was marked by superior shoot and root development. Hoed seedlings had 6.5 feet length with 4.5' lateral, development against 1.7 feet root and 0.5' in control.

Drought resistance and origin of seed:—Source of seed is receiving more and more consideration by foresters as an important factor affecting the survival and development of plants in dry areas. The existence of considerable variation within a species in the power of resistance to drought has been demonstrated frequently with climatic races of oak, ash, larch, spruce, alder etc. *

Several factors seem to be involved such as difference in typical root form, varying adaptability to environment and different transpiration losses. Groups of trees in one region differ from those of apparently the same species in another in their reaction to soil, climate etc. These differences seem to be the result of prolonged natural selection, whereby the more perfectly adapted individuals have survived and attained dominance over ill-adapted. The noteworthy feature is that in several cases there characters are transmitted from parents to offspring. Experiments in America with ash have shown that drought resistances of seedlings bears direct relationship to the conditions under which parents were growing. Progeny from seeds of 39 localities of different drought severity was tested and and it was seen that drought resistance varied according to the length of drought period under which parent trees were growing. For example highest drought period was 107 days, 79 where 73 days and 67 where 45 days. Vigour and growth were similarly superior in case of seedlings which came from parents in drier areas. **

* Is this based on experience, or merely deduction of your own?

* Certainly for ash, but I can't recollect this having been shown for the remaining species that you mention.—R.M.G.

* * Addition of organic matter for improving of absorptive car.

It has further been reported from Russia that the drought resistance of the progeny is affected by the conditions at the time of ripening of seed *** and moderate drought tends to improve the drought hardiness. All this tends to show that the conditions of growth and development of mother trees may have effect on the quality of seed from the point of view of drought hardiness deserves consideration of those interested in the afforestation of dry areas. The place of seed origin should be as similar to the place of planting as possible. Mean temperature of growing season, weather prior to and just after growing season, character of precipitation, frequency of long drought etc. should be carefully considered.

The "presowing hardening" to drought. In recent years interesting work has been reported from Russia to increase the drought hardiness of cultivated plants by presowing treatment of seed. It is believed that these treatments affect the embryonic plants and make it more hardy. It is for example reported that "presowing hardening (attained by repeated soaking of seed to 20 to 30 percent moisture and drying) increased the resistance of subsequent plants to atmospheric and soil dryness. Presowing hardening was found to cause some physiological changes in the hydrophilic properties of colloids, in water holding capacity, water economy, photosynthesis, respiration and other vital functions and also certain other adjustments related to development processes, as the hardened plants were found to respond 'differently to environmental factors' Similar results have separately been reported by another worker as a result of harderning done by triple soaking and drying of seed. He points out more or less a similar improved endurance to drought by the seed treatment.

Now these experiments have been conducted with agricultural crops and I have not been able to find out any similar direct evidence about the improvement in drought hardiness of trees. Here is therefore a field of work of promise for foresters and if Russian experience with agricultural plants proves true with forest seeds, it will enable us to revolutionize our arid area afforestation work.

Nursery practices for producing hardy stock:—

The importance of sturdy drought resistant stock can hardly be overemphasized "where planting is to be restored to instead of direct seeding. During recent years interesting work has been carried out in America, Russia and Canada to increase the drought resistance of stock by treatments in the nursery. Following are some of the successful methods.

Moisture supply and drought hardiness:— It has been shown at the Lake State Experiment station that the drought resistance of nursery plants increased by regulating and controlling moisture supply. The pine seedlings produced from less frequently watered nursery were better hardened and more drought resistant than those from frequently watered nursery. The significant fact from the practical angle is that drought resistance built up by controlled watering persists during the following year and can be of definite advantage in the field. The exact nature of physiological changes about by controlled watering which led to increased drought resistance was not studied but it was noted that root system of such plants was stronger and more extensive than those grown under liberal water supply.

It may, however, be pointed out here that this type of work requires considerable research with each species under varying soil conditions and climates. There is always the danger of "carrying the thing too far and actually weakening plants if the soil moisture content is held at the wilting point for too prolonged a time". This aspect has been demonstrated by a Russian worker by showing that complete withholding of irrigation reduced the drought resistance as compared to irrigated nursery plants.

Fertilizer treatment and drought hardiness:— Extensive work has been done in various countries to study the influence of organic and inorganic manures on the drought hardiness of nursery stock. The response of different species and fertilizers under varying soils, moisture and climatic conditions varies considerably. There is however no doubt that fertilizer treatment influences the external features as well as internal physlogical characteristics of seedlings" and may have either beneficial or detrimental effect upon the drought hardiness. In general it may be said that use of nitrogenous fertilizers gives increase in top growth and those containing phosphorus definitely increase root development. It has been shown by several workers that excessive supply of nitrogen definitely decreases drought resistance. The phosphoric acid which from the very embryonic stages in seed exercises great stimulating action upon the development of roots definitely tends to make plants more drought resistant. Russian workers have shown that application of P and K increased resistances when applied at sowing or during drought. It is held that mineral salts acted not merely as nutrients, but also as activators of certain physiological readjustments which rendered the plants more resistant.

The general conclusion about fertilization work is that it is essential to have a balanced supply

of all the essential nutrients for growing sturdy plants. In one set of experiments it was seen by Wild in America that balanced supply of N, P and K to nursery beds increased average survival in the field from 10 to 15 percent and average height from 20 to 30 percent. It is essential that plenty of P and K should be available and excessive N over and above the necessary minimum should be avoided.

Size of nursery stock and survival in the field. Success in planting under arid conditions depends entirely (?) on the early survival and vigour of growth and this in turn is influenced by the size, top-root ratio, nutrient balance and general vigour of the planting stock. Numerous workers have pointed out the consistent superiority of transplanting nursery stock over seedling trees in survival and growth in sites where soil moisture is a limiting factor. It has been seen that large age classes of stock usually had a better survival and larger root system at the end of the first and second season in the field. Controlled experiments with broad leaved species in Great Plains on the stock graded according to size have shown that premium (What to this?). Stock gave 70 percent and over survival as compared with 40 to 69 percent of marginal and under 40 to 5 percent of cull stock. The grading standards followed for different species vary but in general the smaller grades of slow growing species will give higher field survivals than the same grades in the more succulent fast growing species. If the growing conditions in the nursery are normal, the lack of size in stock may be due to inherent lack of vigour or other hereditary defects of genetic type and therefore the rejection of such plants is well advised. Smaller size classes give poorer results in sandy soils subject to blowing and drifting when compared to trees of same class planted on clay loam soil. In the larger size classes survival is about the same on both sites.

In the planting up of poor sandy soils in the punjab it is a common practice to use plants nearly twice the size of those used for good sites. In recent years the technique of using tall plants of 3 feet height has been perfected in Palestine in the dune stabilization work. One-half of the aerial 3 feet along with the root is burried in the sand to safeguard against exposure due to wind action. The main reason for using larger plants is the insurance against blowing and drifting of sand but the higher survival may be due, partly, to the superior size of stock. This method has incidentally helped to cut short the procedure of dune stabilization in which considerable use of brushwood and grass planting was made prior to taking up planting work.

In another experiment in America the superiority of large planting stock has also been proved in the planting of bare, compact clay soil when drought and frost heaving losses were serious. Losses among smaller stock were almost four times as many as among large stock. The experimental work definitely established that for adverse, compact, clay sites larger stock was superior to small stoc.

Forest Fires.

(With all the Natural Resources, Forests are our national assets and the devastating Forest Fires recurring annually cause a great irrepar-able loss to the Nation at Large. Out of the pangs for the colossal loss, the following fewlines flow:—by S. T. BANASODE, B.A.)

Forest Ranger,
Bagalkot.

PART—I

See the sweeping tongue of Forest Flames!
That licks the humus floor a-clean,
Gulping in the green and lively frames,
Over-towering fire is a deadly scene.
And lo! the barks of tissued wrap,
With hissing sigh and bubbling sap,
Weep and weep unto their last breath,
Falling prey to the prancing Death.
Surging flame leaps up with panther spring,
With new force of golden hands wring;
And rest awhile eating up the wood,
Tearing away the veil of life for good.

Finger flames catching all the verdure,
That mother Earth's plan of treasure;
In the hot pulsating rhythmic prance,
The Demon presides over the Devil-dance.
With the prattling kindles in ghastly air,
And the spiral spray flaming rupture,
Went on the unkind cut of curse unaware,
"Hit at the belt," never known to nature.
Chit-chit notes of burning timbers,
Pistol shots of flying embers
Crackling craters of woody knots,
Thrilled the air at several spots.

Breaking cry of tumbling trees,
Shreiking yell of wild words,
Flashing flights of chriping birds,
Filled the sky with filthy breeze.
In an eye-lash time of Atomic-charge,
Swayed over all the Sylvan barge,
That spell of *God* Shiva's Fiery eye,
Where all must heave a breath of sigh.
Glowing red in rolling fire,
Pack'd in natural fun'ral pire,
Nature with all her lovely gown,
With none *to* care, crumbles down.

DEVA BHUMI OR THE LAND OF THE GODS

By P. D. Raturi, M A., B.Sc., Diploma in Forestry (Hons.—Cantab.)

"One of the most remarkable in the Central Himalayas and for picturesqueness can hardly be surpassed by any valley in the world. Its sides are often absolutely vertical, smoothed down by the torrent, which rushes 600 feet or more down below through a narrow slit in the rocks" (Plate. 1). This is the description of the gorge cut through the great Himalayan range by the Bhagirathi (Ganga) in Tehri Garhwal state, as recorded in Geology of the Central Himalayas by Griesbach, Memoires Geological Survey of India, Vol XXIII, 1891.

In this cradle-land of the Bhagirathi the early British geographers, Rennell (1790), Captain's Ruper and Webb (1810) and Moorecroft (1812) got so much confused by the awe-inspiring lofty sky-scraping mountains and deep narrow valley at the bottom, that they misplaced the source of the Ganga on the southern side of the Great Himalayan range.

GAUMUKH

Gaumukh, the source of the Bhagirathi, known geographically as the "snout of the Gangotri Glacier", is situated on the Tibetian side of the Great Himalayan Range. The two snow-clad horns of Satopanth peaks at the back (Plate. 2), the sacredness of the place and the opening in the glacier through which the Bhagirathi gushes out, all combined are, perhaps, responsible for the name Gaumukh (the mouth of a cow).

Of the movement of the Gangotri Glacier there is no scientific record. But according to Hindu mythology, the Bhagirathi is stated to have descended from its heavenly abode at the present site of the Gangotri temple where Bhagirath sage had been praying for five thousand and five hundred years for the purpose. If this is literally correct the snout of this glacier has moved about 16 miles upwards in 5,500 years, perhaps due to change in climate. Whatever truth there may be in this the face of the snout changes (Plates. 3 & 4).

With slopes rising gently and covered with white snows, mostly perpetual, reflecting birlliantly multicoloured rays of the sun, the bottom part of the valley comparatively wide and made up of boulders, stones. pebbles and freshly formed earth, herds of innocent looking barals (the Himalayan wild sheep) grazing on the alpine grassy pasture, the forest growth ending abruptly with the bushy growth of rhododendron and birch on the down (western) side, the panorama Gaumukh presents is at once elevating peace-giving and illuminating. The outer world is just forgotten and one gets engrossed in the radiating glories of the snows. Pilgrimage to Gaumukh was rare in the past and when the writer visited it in 1936 and, again, in 1937 it was just starting. Beyond Gangotri there is no road, not even a path. Consequently, the secluded birch forest of Bhujbasa near the timber-line, just below Gaumukh is mentioned as the park of Goddess Lakshmi, the presiding deity of the Himalayas.

GANGOTRI

Devoted Hindus from all parts of India

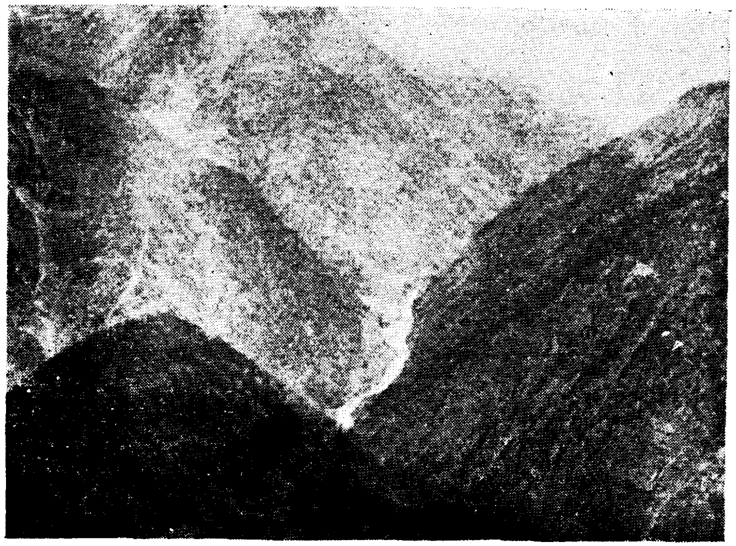


Plate No. 1

Plate No. 2

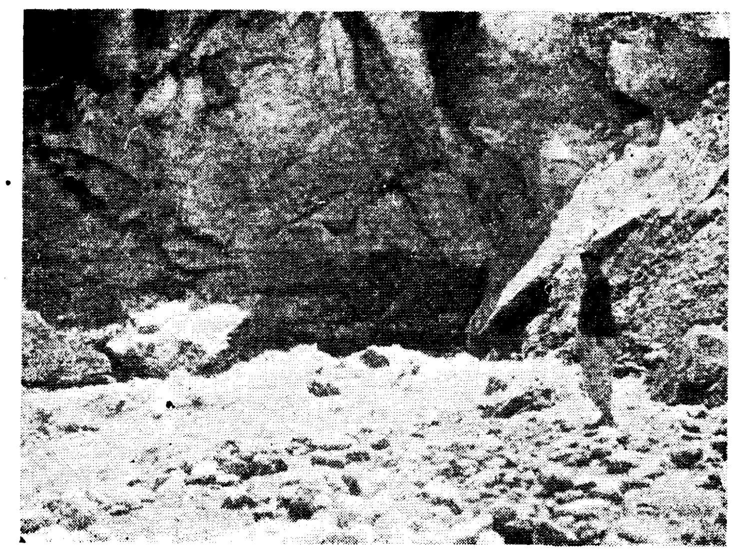


Plate No. 5

Plate No. 6

Plate No. 7

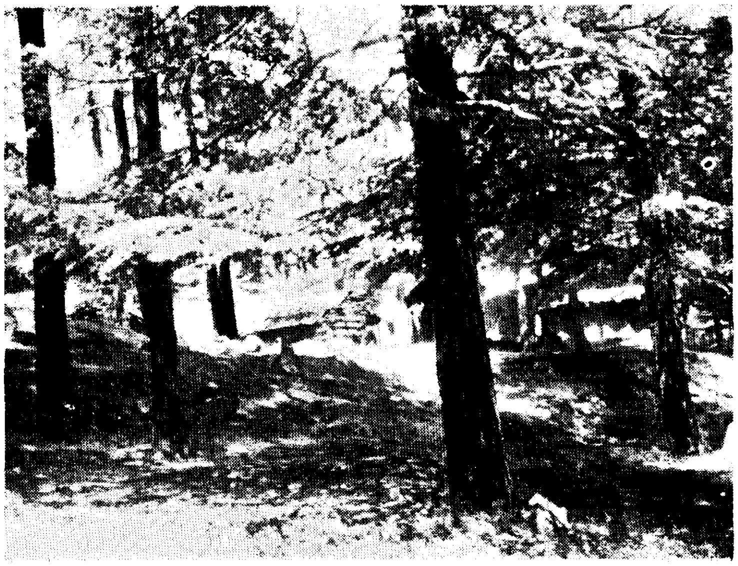


Plate No. 8

Plate No. 9

Plate No. 10

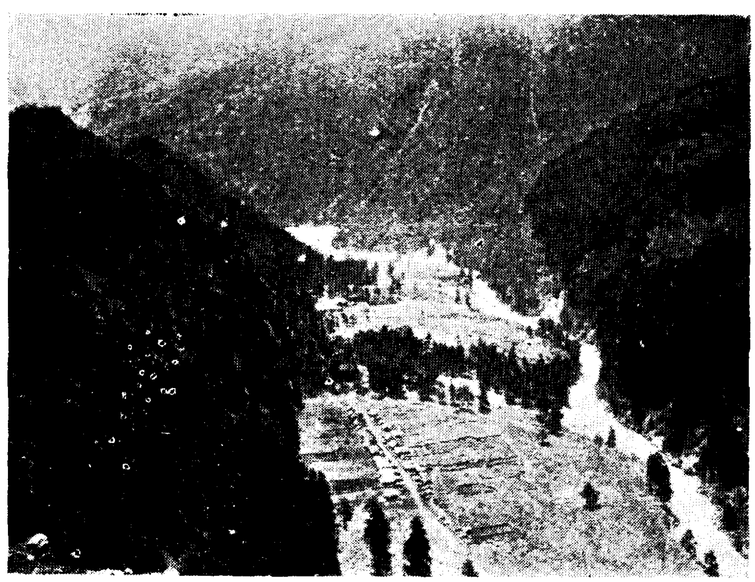


Plate No. 11

Plate No. 12

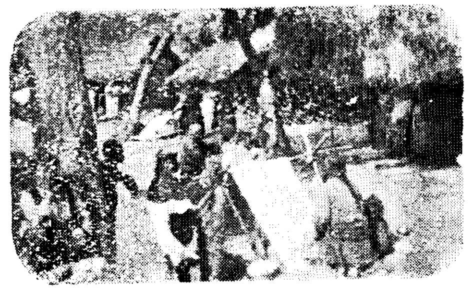


Plate No. 13

Plate No. 14

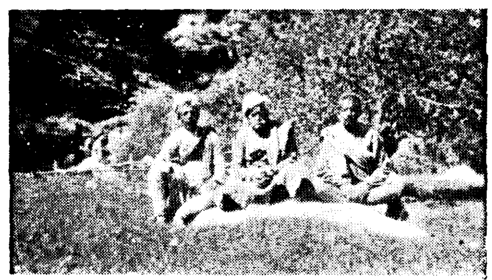


Plate No. 15

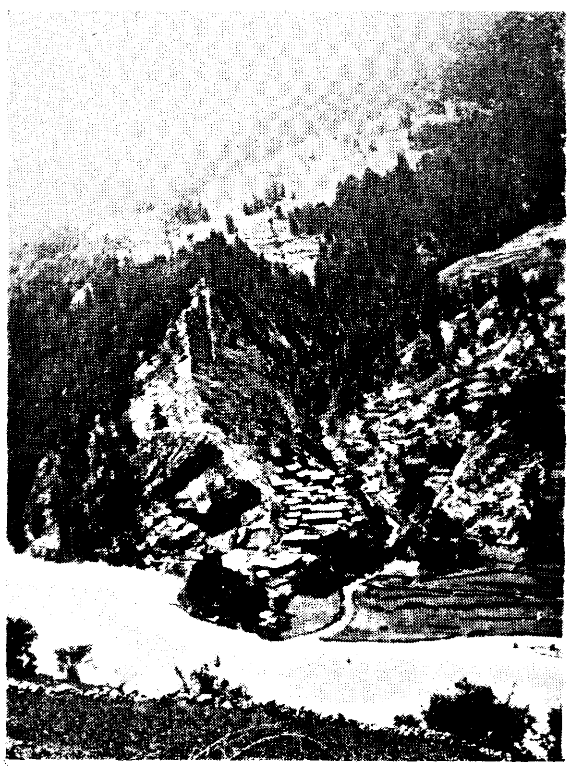


Plate No. 16

visit Gangotri in their thousands, annually, as it is associated with the Raja Bhagirath's successful meditation for 5,500 years and the appearance of the Bhagirathi on the earth.

Later on, the Pandavas are supposed to have come and perfomed the Great Deva-yagnya at this place in atonement for the death of their kinsmen in the epic battle of Kuru-kshetra.

To-day, Gangotri has a shrine of the Bhagirathi and several dharmashalas (Plate. 5). Some well known Yogis have chosen this place for meditation. e g Shree Krishna-Ashramji, Shree Tapobanji, Shree Prajya-nathji, all Scholars of Hindu Philosophy The Late Swami Adbhutanandji (Plate 6). used to do Surya Namaskar from sunrise to sun-set, standing hip-deep in the ice cold water of the Bhagirathi.

Mixed forest of deodar, kail, maple, fir and spruce all round, lends colour to Gangotri. It is reached from Rishi Kesh by a cart road to Tehri (5 miles) and thence by a mule track(101 miles). The track to Gaumukh is 16 miles with a rest house at Chirbasa (10 miles).

The confluence of the Bhagirathi with the Kedarganga and Patangani a mile down on the left bank, are the attractions near Gangotri.

BHAIRONGHATI

About 23 miles from its source the Bhagirathi is met by the Jannavi (or the Jad Ganga) at Bhaironghati. Here, both these streams roll through gorges (Plate 7) several hundred feet deep. The rocks on either sides stand almost vertical in awe-inspiring grandeur. Their combined water, also, rushes down through a similar gorge. These gorges are unique in their ruggedness and form wonderful background for the swift, boisterous and thunderous flow of the Bhagirathi.

At the top of this confluence, on the Gangotri side, there is a temple of Bhairon (Plate 8) with Dharmashalas and seasonal shops.

As if to match Nature's gorgeous display of mighty rocks and tempestuous and majestic flow of the streams below, tall and huge deodar grows around the temple. The Gangotri road bifurcates on the right side of Jannavi gorge and from there a track goes to Tibet. This track is frequented by local and Tibetan traders (Plate. 9) during summer. This is the shortest route to Tibet from the plains of India. The Lama of Thuling Math (Plate 10) took this route while visiting Sarnath a few years back.

HARSIL

Between the gorge at Bhaironghati and that acrsos the Great Himalayan Range at Loharinag, the Valley of the Bhagirathi widens up along its bed, for a distance of about 2 miles, at Harsil. This is the Hari Prayag of yore. Here the Kankoragad and the Jalandarigad confluence with the Bhagirathi. (Plate. 11).

Magnificent forests of deodar, kail and firs on both slopes down to the Bhagirathi, snow capped peaks of lofty mountains rising high up against the sky, flat valley encaging a village humming with life, a temple, a rest house, an apple orchard, the graceful Bhagirathi and its bubbling feeders, all combined go to give the place a charm of its own.

The forests near about and especially in the righ valley are some of the best game reserves of the State. They abound in bharal (blue sheep), muskdeer; thir (wild goat), ghoral, snow leopard, brown bear, black bear, beautiful feathered munal pheasant etc.

Harsil is inhabited by jads mostly of Bushair origin who migrated from their adjoining State in the north via Nela pass. They are mainly traders and deal with wool and its products (Plates 12 & 13). They cultivate the land seasonally (summer) and use yak for ploughing (Plate 14).

MUKHBA AND DHARALI

Two miles up the valley, from Harsil, two villages are situated on oposite sides of the Bhagirathi, Mukhba the village of the high priests of Gangotri who (Plate. 15) are Brahmins by caste, and Dharali,the villagers of which are Kshatriyas, the former store keepers of the said temple. Mukhba is the winter head quarter of shree Gangotri and has holy places e, g. Beer Bhadra at Gum-Gum nala, Mahakali Chandeshwari, Devaghat Markandyapuri and Kachora. Mukhba is said to derive its name from Mangat Rishi who meditated at this place for years. Kachora is supposed to be the birth place of the goddess Maha Lakshmi.

The old name of Dharali is Bishwanathpuri. It has a temple of Bishashor. Near-

by flows down and confluences with the Bhagirathi, the Hatya Harini snow fed stream. (Plate 16).

SHRIKANTH

At the top of Dharali, towards its back, is situated the well known sharp pointed peak of Shrikanth, 20,120. feet. Plate. 17 shows its northern face above Dharali and plate 18 its western face.

The Shrikanth Range is supposed to be the abode of Lord Shiva and frequented by Lord Bishnu and other top ranking gods

This peak is still unconquered and perhaps unattemped. It is visible from miles away and is clearly distinguishable by is sharp conical shape, towering over surrounding snowy ranges.

GANGANNI.

After leaving the Harsil basin, the Bhagirathi gains speed and frets and frowns at every obstructing boulder or rock lying across its path. The multi-colour foams that arise above its surface, the noise generated in its encounter with the obstacles, and the accelerated speed as the bed descends, give the stream the regard, the reverence and the respect the Bhagirathi so richly commands. This boisterous flow goes on till the road crosses the stream over a girder bridge at Dabrani (Plate. 19). Between Dabrani and Bhatwari it is not all rough and tumultuous journey for the Bhagirathi. There occur gentle slopes in the bed with comparatively fewer obstructions, where the river moves calmly and gracefully.

At Gangnani 29 miles from Gangotri, there is a hot spring, on the left side of the stream with small tanks for bath. Dharmasalas for pilgrims and shops are on the opposite side. A forest rest house is under construction near the hot spring.

BHATWARI.

Bhatwari is 38 miles from Gangotri and 63 miles from Tehri, the capital of Tehri Garhwal State. Here, the south western extension to the Great Himalayan range, appears to end. Below it, the Bhagirathi valley widens up and the mountain slopes are not so steep and rough. Also, above Bhatwari deodar appears with kail, fir, spruce and associated broad leaf species. Below it, deodar and kail occur in small patches near a few villages

There is a temple (Plate. 20), a forest rest house, an Aushadhalaya a village school and Dharmashalas at Bhatwari.

By the side of the rest house the Bhatwarigad flows and forms the Bhasker Prayag with the Bhagirathi From a mile, below Bhatwari the pilgrim route crosses the Bhagirath and the Pilang gad, and goes to Kedarnath, across Kush-Kalyan and Panwali mountain ranges.

The road, along the Bhagirathi valley, leads to Utter-Kashi, to Tehri to Deoprayag to Munikireti and Rikhi Kesh.

LAKE REGIONS.

The Kedarnath road crosses the Kushkalyan ridge at the Belab pass, 12 miles from Bhatwari. The pass is an excellent camping ground situated on the water parting ridge of the Bhagirathi and the Balganga. The approaches to the pass on both sides, pass through magnificent forests of high level oak, fir and spruce, of enormous dimensions. Once on the ridge one may tramp for miles on the multi-coloured carpet of alpine flowers, growing on the alpine grassy meadows of the Kushkalyan ridge. The common pilgrim, however, goes right down to Budha Kedar village, about 16 miles from the pass, on the confluence of the Balganga with its tributary. Between these two streams rises from Budhakedar a ridge which nestles Mahasra Tal. This lake is about 6 miles from Budhakedar and being surrounded by huge fir, spruce and oak trees, looks magnificent in its setting, reflecting the sylvan giants.

The continuation of Mahasra Tal ridge, leads to the lake regions of the State, known as Sahasra Tal (thousands of lakes). The latter are perched on the water parting ridge of the Balganga and the Bhillangana at about 14,000' altitude. These consist of a number of snow fed small and one big lake of about a mile perimeter. The ridge bearing these is bleak and sharp edged, much higher than the timber line. There are a number of treks to this region. The one from Gangi, on the Bhillangana is quite good, with the exception of a small bit where it passes over a cliff with hardly an inch or two wide walking space and having a drop of several thousand feet below. Afterpassing this nerve racking cliff, one camps at the side of a


Plate No. 18


Plate No. 19


Plate No. 17

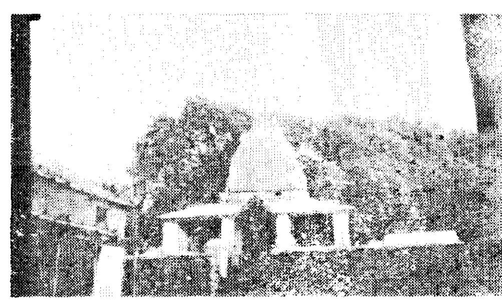


Plate Nn. 20

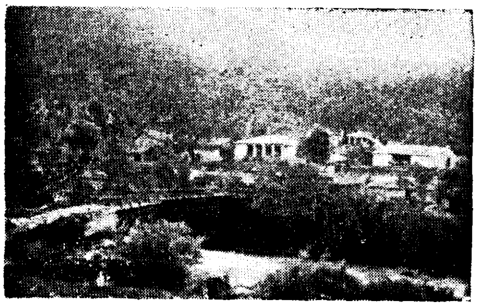
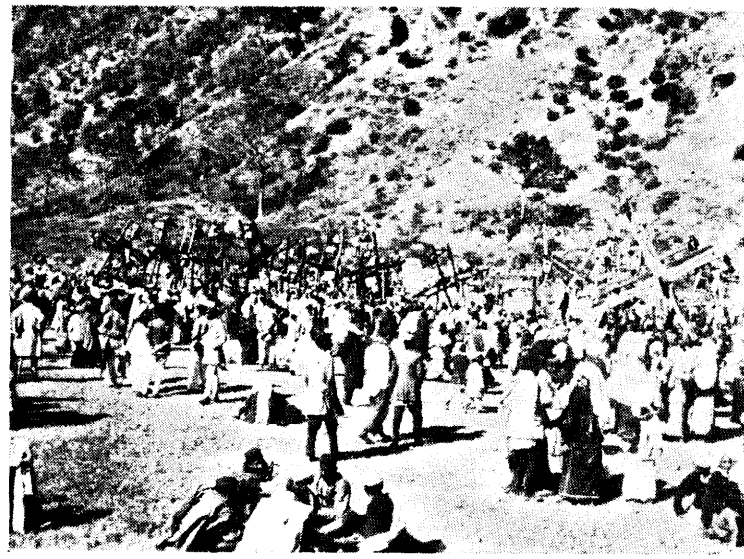


Plate No. 21



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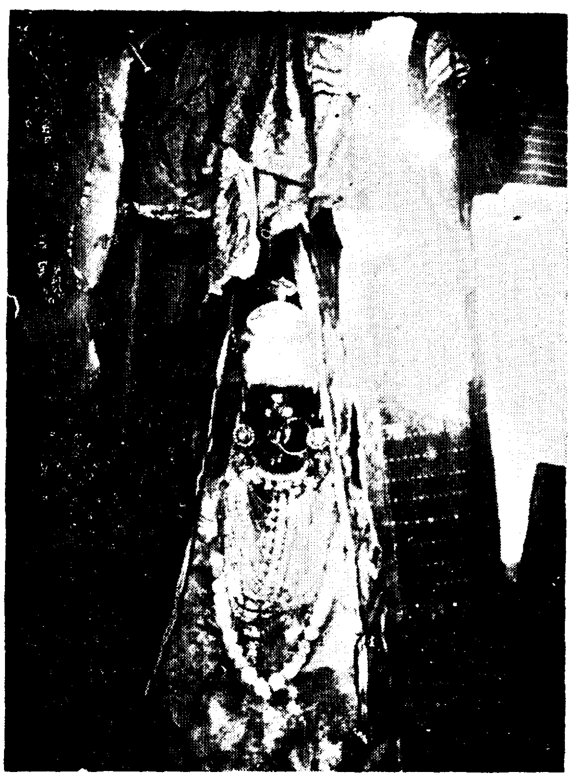

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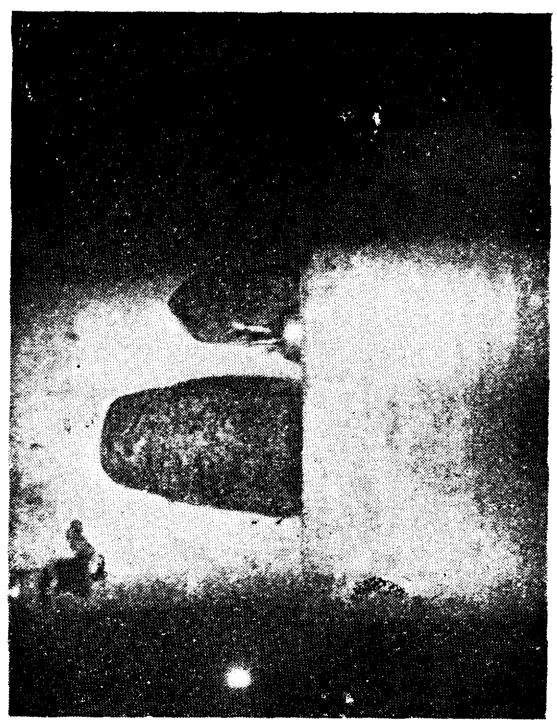


Plate No. 25

Plate No. 26

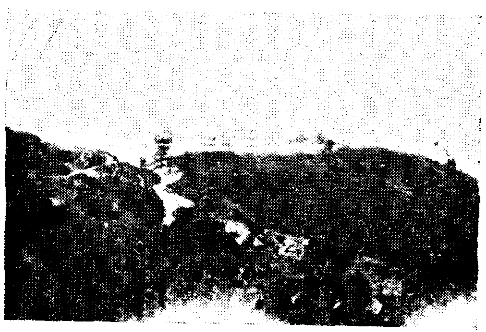


Plate No. 27

Plate No. 28

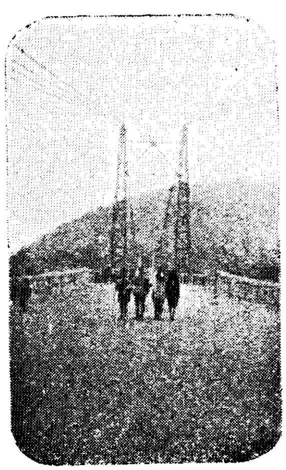


Plate No. 29

Plate No. 30

huge rock knows as Tariodar. It is 3-4 hours' climb to the lakes from this cave. Gangi village is a day's march, half of which is down-hill and the rest along the Bhillangana right bank.

Gangi is about 16 miles from Ghuttu (Plate 21) where the Kedarnath pilgrim route crosses the Tehri-Gangi track. Ghuttu is 36 miles from Tehri along the Bhillangana valley From Ghuttu the pilgrims ascend the Panwali ridge and it is a day's march to the top which has a few Dharmashalas and shops. The ridge itself extends for miles and during summer a trek on its back-bone is delightful. From Panwali it is 2-3 days' march to Kedarnath.

UTTERKASHI.

Going back to the Bhagirathi valley, Utterkashi is 18 miles below Bhatwari. It is a small town hallowed by the temples of Mahadeva and Shokti. It has a hospital, a post office, a middle school, besides being the head quarters of the circle sub-divisional magistrate and the divisional forest officer.

Utterkashi is situated on the confluence of the Buragaddi with the Bhagirathi. Two other streams, the Assi and the Baruna, confluence with the Bhagirathi within a mile or so of the town. Nearby there are colonies of sadhus.

From Utterkashi a track leads to the trout hatchery at Kaldiyani and, further on, to Dodi Tal which is also planted with trouts. The former is 6 miles and the latter about 28 miles from Utterkashi. Dodi Tal resembles Naini Tal in being encompassed by mountain slopes on three sides and open on one side.

From kaldiyani the track bifurcates and goes to Jamnotri on the Yamuna. It is used by the local inhabitants and rarely by pilgrims. The tourist, however, enjoys it.

Annually, in mid-January a fair is held at Utterkashi when people from far and near come to bathe in the Bhagirathi. The village products are brought for sale in the market which remalns open, on the occasion, for 3 4 days. The main attractions of the fair are the Charkies (Plate 22).

JAMNOTRI.

Pilgrims visit Jamnotri before coming to Utterkashi. For this they take the Jamnotri route at Dharasu 18 miles below Utterakshi. Jamnotri is 3-4 days' journey from Dharasu. All along this track there are Dharmashalas and forest rest houses. Jamnotri has a hot water spring and a bath in this for the pilgrims is prescribed. It is 3-4 days' journey from Jamnotri to Utterkashi. On the top of the hillock, near Nakuri, there is a famous temple of goddess Ranuka (Plate 23).

Dharasu is reached from Mussoorie via Magra, Deolsari and Chapra. It is 2-3 days' journey and it is only tourists who take this route In this track one passes through the beautiful deodar forests at Deolsari and Ghoriap top. The former has a cosy forest rest house and is often visited by parties of school boys and missionaries, during summer.

The pilgrims come to Dharasu from Mussoorie via Dhamolti Kanatal Tehri road. This road is quite cool and passes through the deodar plantation along the Dhanolti ridge. There are dharmasalas and also forest rest houses on this road. At Kaddukhol, a trek leads to the Surkhanda peak, well known for the Shrine of the Goddess Sureshwari (plate 24), where a fair is held annually in March-April.

TEHRI.

Most of the pilgrims, however, take the Rishikesh Tehri road (Plate 25). Tehri is 6 hours' run by bus from Rishikesh. Tehri is the capital of the state. It is situated on the confluence of the Bhillangana with the Bhagirathi. The old and new palaces of the Maharaja, occupy the high grounds of the town, which makes them conspicuous. The town, biggest in the State has a population of about 3,000 and has a High Court, a college, a high school, a Sanskrit pathshala, a girls' school, separate hospitals for male and female patients, a post and telegraph office, barracks for the military and the police forces and a jail. Stream lined by the Bhillangana and the Bhagirathi, the town is beautifully situated. Towering over the town is the clock tower (Pate 26).

For pilgrims there are Dharmashalas and for tourists a dak bangalow and State guest houses.

NARENDRA-NAGAR.

Commanding the far flung view of Mussoorie, Dehradun, Roorki, Hardwar, and Rishikesh, the town of Narendranagar (Plate 27) is about 30 years old. It has a population of 1-2,000 and all buildings are

State owned. Besides the Maharaja's palace, and the modern styled annexe attached to it, there are Secretariat buildings, the bazar, the hospital, the barracks, the guest houses and residential quarters for State officers and servants, in the town.

Narendranagar is 11 miles from Rishikesh and 41 miles from Tehri.

BADRINATH ROUTE.

From Munikeriti a cart road traverses the right bank of the Bhagirathi up to Deoprayag and, beyond it, the right bank of the Allaknanda to Kirtinagar. This is the usual pilgrim route to Badrinath. In this journey one enjoys. the views of Swargashram (Plate 28) opposite Munikriti, the Lakshman Jhula (the suspension Bridge, Plate 29, over the Bhagirathi), Shivapuri the confluence of the Hewal with the Bhagirathi, His Highness's country house Shivanga Sadan, the sal and bamboo forests up to Kaudiyala, the precipituous climb beyond Kaudiyala, the graceful curve of the Ganga below Sakinidhar, the confluence of the Allaknanda with the Bhagirathi at Deoprayag, the town of Deoprayag with houses built one over the other, the wide valley of Maleth and, finally, the Kirtinagar town.

Buses ply regularly between Kirtinagar and Rishikesh and the return visit takes only two days.

THE TONS VALLEY.

The pilgrim route to Jamnotri bifurcates at Dandalgaon in the Yamuna valley and leads to the Tons basin via Barkot and Mugra on the Jamna, Purola on the Kamalgad and Ringali on the water parting ridge of the Kamalgad and the Tons (Plate 30). There are forest rest houses at Barkot, Purola and Ringali. The last is connected with Chakrata by a pack pony track, being only two days' journey. It is frequented by Shikaris.

The Tons valley, in spite of its proximity with Jamnotri, is not prescribed for pilgrimage and is, therefore, beyond the trek of the pilgrims. It has attracted the shikaris only, so far.

The Tons valley is rich not only in wild game but also natural scenery. The murmuring brooks of the Dedragad, the gigantic fir, spruce and deodar trees of Balcha, alpine meadows of Chansil and Saunkantha, the Tons basin at Hari-ki-dun are just a few out of many places where Nature's assorted beauties are just scattered for the tourists to ose and pick.

A NOTE ON THE RESTOCKING OF AREAS OVER EXPLOITED DURING THE WAR

BY T. K. MIRCHANDANI,

Conservator of Forests, Bombay.

G/12302/Bo., G/340/Bo.—To supply timber, fuel and bamboos for the defence department, during the war, fellings were done in advance areas beyond the working plan and the girth limit for exploitation was lowered. A schems of rehabilitation is outlined.

1. This note it based principally on experience of *Kanara Northern* Division (Blocks I to VII) of Southern Circle of Bombay Province. As this Division supplied more than half the output of timber for War supply from the Southern Circle, the suggestions made in this note may generally be applicable to other Divisions of Southern Circle.

2. The supply of Forest Produce for War purposes consisted mainly of:—

(a) *Timber* required for all branches of Defence Services.

(b) *Firewood* for the Army and Civil Supply.

(c) *Bamboos* for the Army and Civil Industries supporting war effort.

3. In order to meet the requirements of timber for Defence Services the *provisions of Working Plans were held in abeyance* with the sanction of proper authority. Following two methods were adopted to exploit and bring to rail head all the timber required:—

(i) By exploitation of Advance Areas beyond the prescriptions of the Working Plans.

(ii) By lowering the girth limits for exploitation under selection

method of marking trees for exploitation.

The species exploited was mainly teak although other hardwoods were also extracted to a larger extent than in peace time.

4. Out of a total number of 151 teak bearing compartments in Blocks I to VII as many as 109 compartments were worked for teak down to a girth limit of 5' at B.H. instead of prescribed girth limit of 6'6" at B.H In terms of annual increment this represents a growth of 50 years i e. an advance exploitation of an increment of 50 years in a rotation of 120 years.

5. Partly due to faulty prescriptions and calculation of possibility from these forests as laid down in the Working Plans but mainly due to pressure of War operations, it has been calculated that *on the whole* we have drawn from these forests annual possibility by 36 years in advance. In terms of volume this represents a loss in capitl o nearly 50% of the growing stock because only the best trees in the penultimate classes, representing the exploitable yield of next two felling cycles, (i.e. 40 years) have been removed.

6. The result of the above operations is that in many cases there are large gaps in the canopy. In most of these 109 compartments, worked down to a girth limit of 5' for teak and 4' for other hardwoods), there is very litt'e teak or superior growth left standing.

7. Following suggestions are made for a rehabilitation prescription for these forests for next 20 years:—

(a) The 109 compartments worked irregularly should be gone over again in next 20 years (say 5 compartments, per year) and only *felled* timber left on the ground as not suitable for war supply and trees over 6'6" girth at B H. marked for exploitation but actually not felled because they would not supply timber upto war supply standard, should be worked departmentally and timber brought into depots for sale. Departmental exploitation is recommended in order to prevent any unauthorized felling of standing trees. No new marking, under whatever pretext, should be carried out in these compartments during this whole period.

(b) The plantation programme as laid down in the Working Plans is behind time by about 9 years. This can be made-up if following clear felling and plantation programme is maintained for next 20 years.

Dandeli Range	... 50 acres per year.
Kulgi Range	... 185 acres per year.
Virnoli Range	... 185 acres per year.
Total	... 420 acres per year.

(c) The plantations should chiefly be confined to compartments accessible to rail head and will not for a long time make any appreciable impression on these over exploited areas. For this purpose some sort of diffused artificial regeneration on a mass scale is necessary. It is suggested that compartments which have been given the 'cleaning up' prescribed in sub para 7 (a) above should be taken up for these operations. All debris in these compartments should be burnt and stump planting of teak should be carried out in strips 66' wide. It is not necessary that these strips should be drawn by a parallel ruler. Nor is it necessary that they must closely follow the contour. The strips should follow the natural gaps in the forest in order to minimise the felling of standing trees and where possible obtain a continuous strip from one end of the compartment to the other. Steep nalla banks and rock outcrops should serve as breaks for these strips. Where there is a group of healthy natural growth of teak or superior hardwoods a strip should be terminated at that point and another one started from the nearest natural gap in the canopy. This large scale stumping of teak in about 5 compartments (nearly 3,000 acres) per year will need an excellent organisation of central nurseries for the manufacture of the stumps and this work should be taken in hand immediately. Also the stumping will have to be done by some mechanical appliance

(like planting machine) in order to complete all work before rains.

This regeneration should be looked after for two seasons and thereafter it will have to be left to look after itself, as established "natural" regeneration, During the next 10 to 15 years the Bamboo in these forests is likely to flower and die. This will give an excellent opportunity to this regeneration to shoot up. Rigid fire protection for the next 10 years or so is sine qua non for the success of the above method of mass regeneration and in this connection proposals made in para 6 of Divisional Forest Officer, N.D. Kanara's No. D-253 of 28/30 April 1945 (appendix A) are commended for serious consideration.

8. Teak pole areas have also suffered serious depletion of poles of larger girth classes due to irregular exploitation for electrical transmission lines and telegraph poles. The rehabilitation prescription for these forests is to reserve most promising young poles as timber reserves for the next rotation. On an average about six timber reserves per acre would more than compensate for the loss due to war exploitation.

9. As regards firewood most of this has been obtained by advance working of coupes of coppice forests. The exploitaion can be normalised within next 10 years by not working one coupe in alernate felling series in those felling series in which irregular fellings have been carried out.

10. No serious depletion has taken place in bamboos due to war exploitation. In fact in view of the imminence of flowering of bamboos in Kanara forests early steps should be taken to exploit the existing growth by the accelerated cuttings for industrial purposes like pulp manufacture etc.

APPENDIX A

Para 6. With the programme of nearly 400 acres of plantations per year the problem of fire protection will assume increasing importance. Rigid fire protection for the first 10 years of its life is a sine qua non for successful establishment of a teak plantation. But from experience of past several years it is found that this will be impossible to achieve with the present habits of the local villagers who inhabit the scattered hamlets in these forests and set fire to these jungles *every* year. I therefore recommend that the few villagers in the Kulgi and Virnoli ranges should be evacuated and settled in Dandeli village where there is plenty of fertile land suitable for agriculture.

The advantages of this proposal are that our future plantations in Kulgi and Virnol ranges will be immune from fires started by these villagers. On the other hand the advantages to the villagers themselves are many and varied.

(a) At Dandeli their agricultural and garden produce being near the railhead will fetch better prices than in the remote villages.

(b) Amenities of medical aid and sanitation would be extended to them which are non-existant in their remote hamlets.

(c) Their children will be educated in Dandeli shool while they have no schooling facilities in thier present homes.

(d) With the development of water supply and electricity at Dandeli these services would also be extended to them.

(e) Their crops will be less liable to damage by pigs and other wild animals than in their present sites.

In fact the villagers will benefit both in health and wealth if they are transferred and settled in Dandeli.

Due to the conditions created by war, the cost of the transfer would not be much because the timber standing on this virgin land will more than pay the cost of clear felling and terracing the land to make it fit for cultivation,

SALINE AND ALKALINE SOILS AND THEIR AFFORESTATION PROBLEMS

By

Om Prakash Bhargava B.Sc., Dip. For. (Oxon), A.I.F.C., Working Plan Officer, Madhya Bharat.

G/1213/I.S.—The genesis of saline soils is traced and the status of halophytes is examined followed by an account of the afforestation work taken up.

In the drier tracts of India there occur vast stretches of land where on account of high salinity or alkalinity the cultivator finds it uneconomic to grow agricultural crops. These generally occur in the East Punjab, the United Provinces, Sindh, Deccan (Bombay) and Bihar and also in most parts of Rajputana, Madhya Bharat, Savrashtre and Deccan States. In the United Provinces alone this area has been estimated to be about 2,000,000 acres out of which about 1,800,000 acres are under alkali soils and about 2,00,000 acres under saline soils. It has also been found that the saline areas are increasing at the rate of 25,000 acres per annum in the canal irrigated lands. Figures for all Provinces and states in India are not available but very likely the total area of such soils in India would be about 10,000,000 acres out of which about 3,000,000 acres lie in the dominion of Pakistan.

In the field one comes across soils which vary from normal to all the intermediate stages of salinity and alkalinity. In fact it is very difficult to draw a hard and fast line of distinction between the different types. The exact processes involved in the transformation of normal soils to saline and alkaline did not come to light in the beginning. In 1876 the Government of India set up a "REH" committee to investigate the causes of formation of saline soils. The Russian Scientist Danilousky's work published in 1884 is of an outstanding nature in this connection. It is however necessary to emphasise that the field work on these soils has been done from the agriculture point of view and very little from the point of view of forestry.

Saline soils are formed in arid or semi arid climates where the precipitation is less than the quantity of moisture lost by evaporation. There is an accumulation of salts in the surface layer and most commonly this happens when there is a high water table and a low humidity resulting in upward movement of water by capillary action and the salts are left accumulated in the surface layers as the water evaporates. In many cases the high water table is caused by the existence of an impermeable layer or hard pan in the sub soil. It has been shown in the Punjab that when shallow irrigation is given, salts already present in the soil are washed down and form a zone of accumulation at a depth of 3 to 4 ft. from the surface. If more water is supplied this may move downwards but if the land is left fallow and no irrigation is given, then the zone of accumulation moves to the surface of the soil resulting in the formation of a saline soil. Similarly the process of formation of alkaline soils according to de Sigmond is also a bit complex. The colloidal clay particles in the soil behave as large complex anions and possess the property of absorbing cations of the various base elements like calcium, magnesium, sodium and potassium. Normally in the alkaline tracts soil colloids are charged with calcium and magnesium ion. Calcium when present on the colloidal complex of the soil helps to maintain its crumb structure whereas the colloidal particles charged with sodium or potassium have the property of getting dispersed in water and they impart to the soil the undesirable properties of stickiness and impermeability. If the salts in saline soils are rich in sodium salts (which is very common) and poor in soluble calcium salts the sodium cations will displace the calcium cations from the colloidal clay particles of the soil. It is this process of replacement of calcium and magnesium ions on the colloidal complex of the soil by sodium or potassium-ions through base exchange which is termed as "Alkalisation."

After the processes of salinisation and alkalisation described above have been completed the next step in the evolution of alkali soils consists in desalinisation or the washing out of the excess of soluble salts from the alkalised soils. This may take place on account of flooding, natural or artificial. By this process the soil becomes poorer in soluble salts and the soil colloids which are charged with alkali cations disperse on account of the removal of the coagulating effect of the electrolyte or the salts.

As a result of the above stages de Sigmond has divided the saline and alkaline soils into the following four classes :—

1. Saline soils, (2) Saline Alkali soils. (3) Desalinised or leached alkali soils (4) Degraded alkali soils.

Saline soils have a pH value of about 8.5 to 10. In the case of leached alkali soils on account of the dispersion of the alkalised colloidal clay particles due to the removal of the coagulating effect of salts the permeability of these soils both to water and air is greatly decreased. Even after many showers these soils may get wet only a part of an inch deep. This is due to the swelling of colloids and he resulting increase of volume which closes all the pores and makes the soil impervious. The characteristic features of typical alkali soils are that they have a compact structure, are almost impermeable to water and are strongly alkaline in reaction and if the soil is mixed with a large volume of water one finds a turbid solution which does not get clear even after months. The fine soil particles in these soils are often washed down-wards and form an impermeable hard pan in the deeper layers of the soil.

Properties of saline and alkaline soils that adversely effect plant growth can well be recogzised if the above processes are fully appreciated. Plants growing in alkali soils usually-suffer from lack of moisture due to impermeability of the soil, lack of oxygen for roots which again is due to compactness of the soil, and corrosive and toxic action of certain substances such as sodium carbonate and soluble aluminates. The latter are usually formed when the pH value of the soil is over 10. The alkaline soils are poor in nitrates because nitrification by the soil bacteria is greatly restricted above pH 7.5. Plants growing in alkali soils often suffer from many nutritional disorders such as lack of iron, calcium and phosphorus. This may be due to the unavailability of certain elements to the roots in alkaline surroundings.

Plants grown in saline soils are known as halophytes. Some halophytes are able to secrete salt from the surface of their leaves and sometimes their stems through hydathodes. Morphological studies have shown that halophytes have generally a tendency towards succulency and develop thicker leaves and stem and that they have a more pronounced palisade parenchyma, smaller intercellular spaces and often diminution in the number of choloroplasts.

As far as the utilization of saline and alkaline soils for growing useful plants is concerned there are two ways of utilising them. One is to use such soils in their existing state and grow on them plants that are resistant to the adverse factors found in such soils and the other is to improve and reclaim them so that ordinary plants can be grown. The latter operation for afforestation purposes is rather expensive and as such attempts are only made to put in such plants which can fight and be tolerant to these adverse conditions. There are many grasses and herbaceous plants which naturally grow on alkaline soils and are grazed upon by cattle. By effective rotational grazing yield of such grasses can be considerably improved. Seeding the area with these tolerant fodder grasses further improvement can be achieved. Bermuda and Rhode grass are reported to be tolerant to strong salinity while in the Indian conditions Rosa, Vetiveria Zizanoides and Dab are the most common to occur. Palms can withstand strongly saline soils and specially Khajoor seems to be well suited to such localities. Amongst the timber and firewood trees of India the following species show resistance to the alkaline conditions in varying degrees:—

Acacia arabica, Butea frondosa, Acacia catechu, Tamarindus indica, Melia azedrachta, Casuarina equisetifolia Albizialebbek and some species of Eucalyptus (E. rostrata).

The writer had been making experiments of afforestation during the last five years on an alkaline area which is about 10 miles from Gwalior City and is known by the name of "SUSERA RAMNA". The conditions which existed in the area in 1942 may be summarised as:—

1. The tract was constituted into a Ramna or a Shikar Reserve for deer shooting by the Maharaja out of the waste land of about 10 villages. The total area of the tract being about 300 acres.

2. Herds of deers were tamed and regularly fed in this area. In addition the cattle of ten villages numbering about 7,000 were allowed to graze and stray, feeble cattle of the city public were also maintained in the form of a "Goshala". Grazing incidence being excessively high the growth of vegetation got retarded.

3. There are barren patches of whitish colour visible to a visitor. The structure of the soil is compact almost impermeable to water. Even after a heavy rain the soil gets wet only a part of an inch deep and the outer layers almost serve as rain coat.

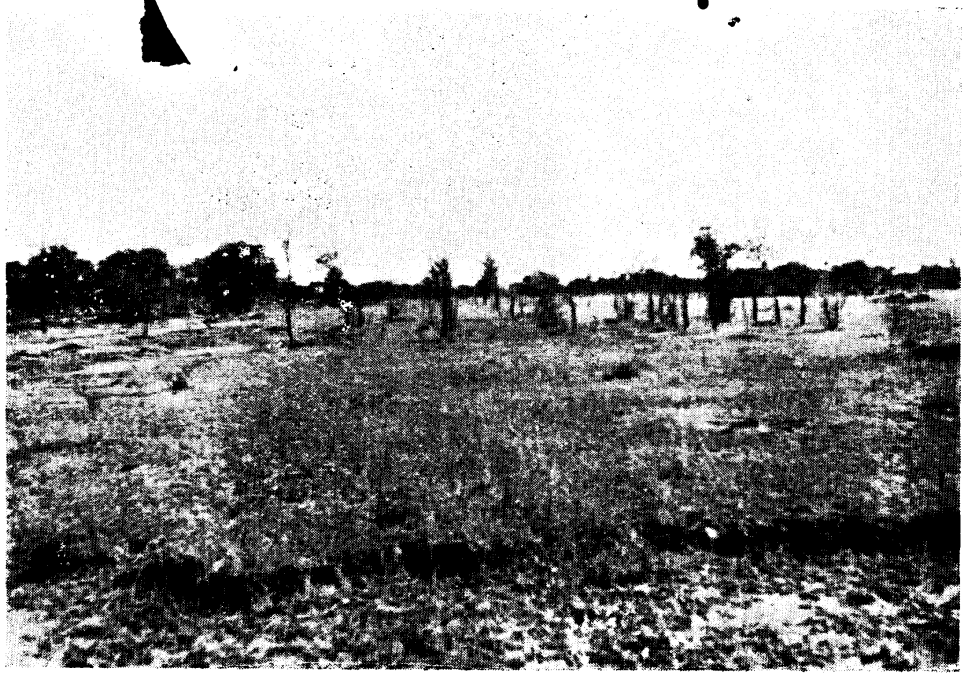
4. Sub-soil conditions denote water table as high as 4 to 5 feet in winter receding

Sowings of Prosopis Juliflora seed on mounds on the alkaline area at Susera.

Photo by O.P. Bhargava.

Treated root and shoot cutting of prosopis Juliflora (one year old) planted on the alkaline patch.

Photo By O P. Bhargava.



Four years old plantation.
Plants raised by Taungya method on alkaline soil at Susera.

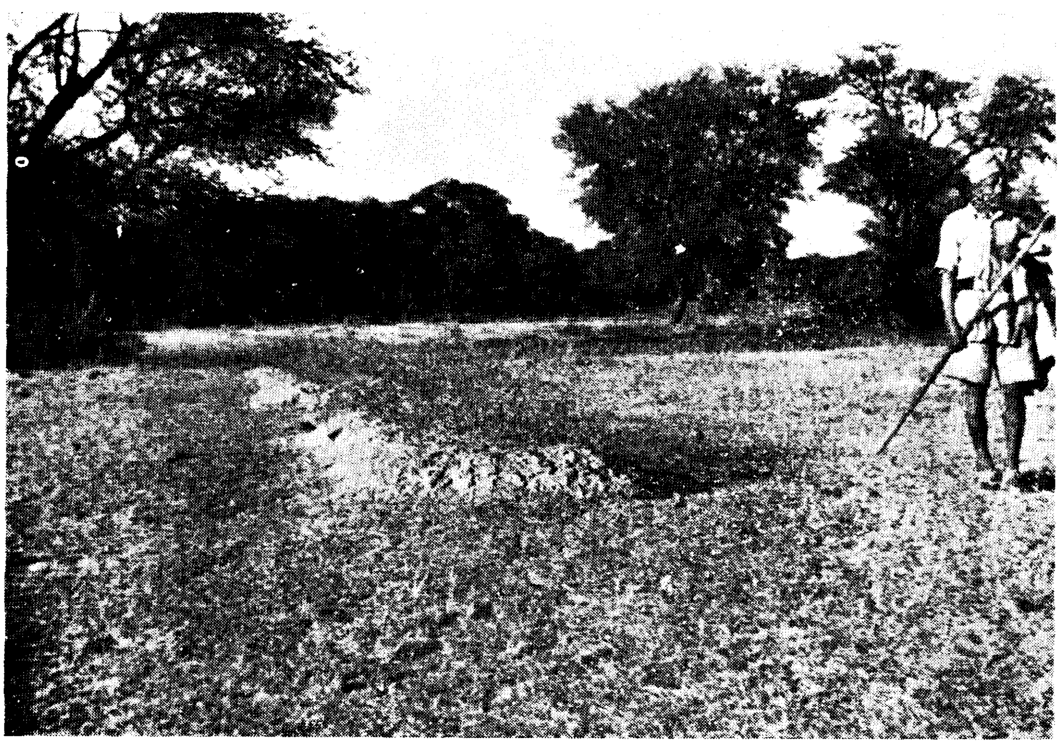
Photo By O P. Bhargava.

Pit Plantation of Terminalia spp. on highly alkaline area at Susera.

Photo By O.P. Bhargava.

Platform 20′x4′x2′ prepared on the alkaline area out of non-alkaline soil and seeds of Prosopis Juliflora sown in 1948 rains. Seedlinga are about 24″ high (Jany. '49).

Photo By O.P. Bhargava



Platform (10′x4′x2′) prepared on highly alkaline area out of non-alkaline soil and seeds of Acacia arabacia and Buteaf frondosa sown in 1948 rains seedlings are 29″—24″ high.

up to 10 feet in summer. It appeares that the cause of high water table is the existence of an impermeable layer or hard pan in the subsoil which has got formed due to the fine soil particles being washed downwards and accumulating in the shape of a hard pan.

5. There occured wide blanks with stray trees of Babbool (Acacia arabica) near the banks of small rivers and nalas. Date Palm (Khajoor) trees are in abundance. Growth of grass is very sparse. Natural flora is very poor and mostly consists of few coarse grasses including Vetiveria Zizanoides and Saccharum species.

Work Done:—

1. Immediately after taking over the area, (1941-42) it was constituted into a reserved forest and grazing was prohibited. The tract consisted of slightly undulating areas and on the raised patches afforestation through Taungya was undertaken. Jowar was the agricultural crop sown, in between the lines 25 feet apart while on the lines seeds of Acacia arabica was sown. On the low lying patches similar sowings were done in the lines but no agriculture crop was raised. Germination on the Taungya was good but very poor in the low lying areas. In the subsequent winter as a result of severe frost all the seedlings got killed. It was observed that the seed and seedlings were very sensitive to salt injury and as soon as there was accumulation of salt in the surface layers, seedlings started withering.

2. Next year in 1943 a nursery was estiablised and stock from seed of the following species was raised:—Casuarina equisetifolia, Dalbergia Sissoo, Albizzia procera and A. Lebbek, Bombax malabarium, Terminalia arjuna. These were transplanted in the following rains in the pits dug (3′×2′). Tillt September they all exhibited good progress but by December almost all had withered and there was evidence of accumulation of salts in the pits.

3. Attempts in 1944-46 were made to change the technique of planting and care was also exercised with regard to the selection of species and soil preparation. The following procedure was adopted

A Soil preparation:— (i) Trenches 2 feet deep were dug and filled with artificial non-alkaline soil and the mounds on them were raised as high as 9″ to 12″.

(ii) The pits 2′×2′ were dug and also filled with non alkaline earth and level was kept about 3″-4″ higher than the surface-sloping from centre to the sides.

(iii) Where the soil was not changed attempts were made to wash the salts down into the soil by irrigation before the seed was sown. Rising up of the salts to the surface was prevented by further watering and also by working the soil intensively to break up the capillaries. Mulching was also tried in some cases.

B. Selection of species:— (i) Selected species which were raised in the nursery were:—

Casuarina equisetifolia, Prosopis juliflora, Pongamia glabra, Terminalia spp.

(ii) Direct sowings of the following was adopted in the lines:—

Acacia arabica, Acacia catechu, Butea frondosa, Prosopis juliflora, Tamarix Sp. Melia azadirachta.

C. Method of Planting:— This consisted in the preparation of twelve months old root and shoot cuttings in the last week of March. Around each stump was put a ball of wet sandy loam earth moulded into a cylindrical shape about 10" long and of 3″ girth. In the centre of this was placed the stump. Wet grass (Gander or Dab) was tied round it and a sort of earthen pot or Dona' was prepared which could be kept straight with lower portion of the stump downwards and shoot upwards. These were kept under partial shade on stone or brick platforms and were moved every week so that the roots may not penetrate the brick platform and not get into the soil. Watering in the morning was done for three months. These were termed as "Treated Cuttings" and were put in the previously prepared pits in 1st week of July when monsoon had well set in and there had been at least one good shower.

Results:—(i) Sowings on the mounds did show good results but withering started next summer and it appeared that constant watering in th 5 dry months was necessary to retard the upward movement of the salts. Watering therefore continued in 1946 & 47 in part of the sowings and these are still thriving. Where watering was not done seedling have failed.

(ii) In the pits also where watering continued treated stumps did very well and have now well estabilised themselves.

(iii) Change of the soil helped the seedlings in the first year but later on non-alkaline soil got strongly alkaline after dry season had passed.

(v) Amongst the species Prosopis juliflora has only survived. Casuarina started very well but failed in 3rd and 4th year. Tamarix seeds did not germinate and cuttings surprisingly failed.

4. During 1948 platforms of non-alkaline soil from the adjoining areas were prepared on the alkaline patches and seed of Prospopis juliflora and Acacia arabica in intimate mixture has been sown. Germination is very encouraging and progress of seedlings is being keenly watched. So far it appears that washing down of the salts for the platforms will considerably assist the establishment of the seedlings It has also been noticed that addition of organic manure seems to be beneficial. It is anticipated that after the seedlings are well established the salts will not usually rise to the surface because on account of the absorption of water by the crop roots there will not be much upward movement of the moisture. No conclusions can however be drawn today.

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TIMBER, ITS STRUCTURE AND PROPERTIES

BY H. E. DESCH.

Second Edition, Macmillian & Co. Ltd., 1947 ; Price 18 Shillings.

Since the first publication of this book in 1938, it has been much in demand by those who are generally interested in timber. The author, after his release from captivity as a prisoner of war has taken the earliest opportunity to bring the book up-to-date. The progress in wood technology during the last war has been very considerable, and by bringing the book up-to-date, Dr. Desch has done a good service to all who are interested in timber as a raw material. In Part I, he deals with the structure of wood in some detail. Coniferous timbers and timbers of broad-leaved species are given under separate chapters. Here it is difficult to appreciate the use of the terms "softwood tissues" and "hardwood tissues" in a standard book like this.

In Part II, the author deals with gross-features of wood such as sapwood, heartwood, growth rings, compression wood, tension wood, grain, texture etc. He treats each item from the point of view of timber utilization. This will undoubtedly help timber users and put them on their guard. A word of criticism may not, however, be out of place here. Some items are disposed of in a rather cursory manner, taking little notice of recent researches. For example, definition of growth ring is not quite correct, while under compression wood there is not much information.

In Part III, the properties of wood are given. The density of wood is followed by strength of wood, which includes important subjects like micro structure of cell wall, influence of defect in strength, and stress grading. Then comes moisture in wood, and heat conductivity of wood.

After having given a general idea of the properties of wood, the author gives in Part IV, details of seasoning of wood, defects of timber, preservation of wood and grading of timber. In the last chapter of this part, he deals with wood as an engineering material. It is here that he brings out admirably well many points about timber by which it may be considered superior to its competitors, e.g. steel and reinforced concrete.

The book has been excellently produced. It contains a large number of illustrations, which will no doubt easily bring home the subject matter to readers. The author is to be congratulated for producing such a book at the present time.

K. A. C.

RELEASE No. P/875.

AUSTRALIAN SCHOOL CHILDREN RUN PINE PLANTATIONS
PLAN TEACHES PRIDE IN NATIONAL HERITAGE

BY BETTY GILL

Photographs by Ken Dicker

Training in the care and preservation of forests forms part of the education of many Australian school-children.

From the age of five they take an active part in all phases of afforestation—from the clearing of the land for planting to the felling of the timber.

Practical experience and lectures give pupils an intelligent appreciation of the beauty of trees and the importance of forests in the nation's

life. They learn of the role of forests in water conservation and control of soil erosion. They develop a "forest conscience" against destruction of forests by fire or ruthless exploitation.

Not only do the youngsters spend many happy hours in this healthy outdoor activity, but under the School Endowment Plantation Scheme inaugurated by the Victorian Department of Education, revenue from the sale of timber swells the funds of their schools. This helps in the provision of amenities and educational aids for the schools, such as libraries, film projectors, construction of basket ball courts, tennis courts and lawns and gardens. It also helps to finance developmental work on the plantations. The Education Department assists the schools by supplementing the revenue received from the plantation.

Typical Examples.

A small bush school at Yarrambat, 15 miles from Melbourne, offers a typical example of school forestry work. Here, 27 children of from 5 to 12 years tend a six-acre pine plantation under the enthusiastic leadership of their headmaster. The plantation has been in existance for 19 years, and the first thinning stage has now been reached. Generations of school-children have worked on it from the time of clearing. They have been responsible for fencing, planting, burning of fire breaks, pruning, felling and logging.

It is estimated that the first thinning will produce 3000 feet of case logs and three cunits of pulpwood, valued at Rs. 300. The Education Department's subsidy will bring up to Rs. 900.

A State school at Creswick, also near Melbourne, is another school that runs a successful endowment plantation. In 1924, five acres of an old mining lease overgrown with gorse and broom was taken over, and put under Pinus radiata. The trees flourished on this unprepossessing site, and the final clear cut was made in 1946. The total production of timber in all classes was 204,788 super feet, including 26,454 super feet of peeler logs, which gave a net return of Rs. 8,000.

Plantations are administered by school committees, consisting of the district inspector of schools, the head teacher, chairman of the school committee and locally elected trustees.

Land for plantations may be purchased by the school committees, may be a gift from interested citizens, or may be made available by municipal council. Usually, however, it is Crown land held under permissive occupancy from the Lands Department.

Government Co-operation

The State forests Commission co-operates closely with the Education Department in this branch of its activities. It bears 80 per cent of the cost of materials for fencing and nursery establishment. Trees and seeds are supplied to the schools free.

Co-operation is carried further by the personal interest of District Foresters, who lend a helping hand in the care of the plantations and give interesting addresses to the children on the forests in their district. This provides a valuable link between the children and community activities.

To oversee the activities of the various schools tending pine plantations, the Victorian education Department has appointed a Supervisor of School Forestry, whose duties include inspection of proposed plantation sites, advice trustees in the choice of species to be planted, guidance to trustees in the felling and marketing of timber, organisation of vacation schools of forestry for teachers, and lectures to students in the college.

At present there are 350 established plantations in which 420 schools are interested. Partnerships and group school plantations cover 94 schools. Several of these partnerships link city and country schools, providing a valuable social contact between city and country children. Usually, the city school provides the funds while the country partner carries out the greater part of the actual work and exercises the necessary supervision.

Most plantations cover seven acres, but some run to 46 acres. Aggregate area now exceeds 3000 acres.

The most widely planted tree is the Monterey pine (Pinus radiata), a softwood which has flourished in Southern Australia since its introduction from America. Australian native hardwoods such as sugar gum, gray box, yellow box and various wattles suitable for tanning are also planted.

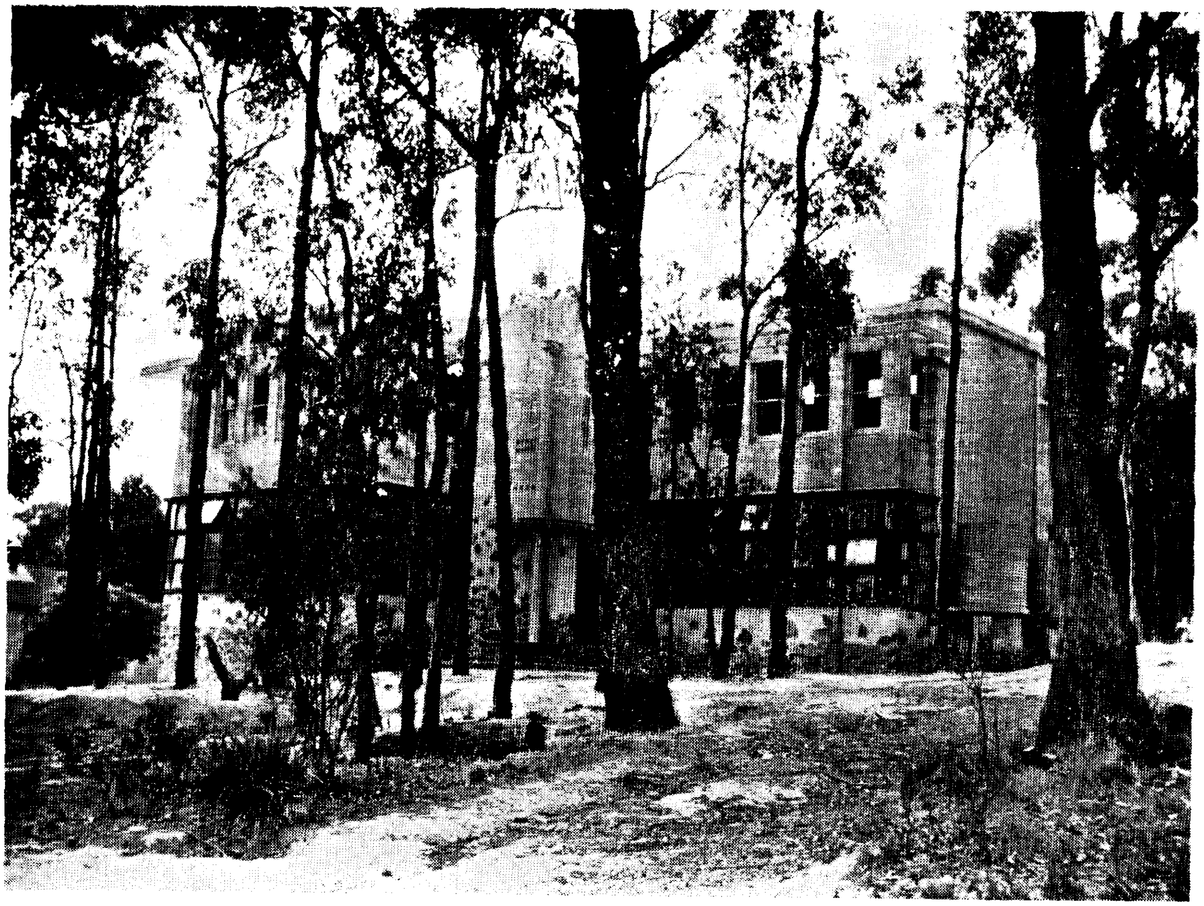
Australian School-children Run Pine Plantations

Training in afforestation forms an interesting part of the education of many Australian school-children. They take an active part in all phases of the work—from the clearing and fencing of the land to the felling of the timber. Revenue from the sale of timber purchases amenities and educational aids for the schools.

L2478. (48)

After the tree has been marked for felling, it is measured and details are entered in the tally-book. Here, the Supervisor of School Forestry, Mr. A.L. Godfrey, checks on a reading by the children.

AUSTRALIAN OFFICIAL PHOTO.



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L2487, (48)

The Upwey Primary School, a bush school which is to share with four other country schools, management of a pine plantation to be established at Kallista in the Dandenong Ranges, Victoria.

AUSTRALIAN OFFICIAL PHOTO.

Australian School-children Run Pine Plantations.

Training in afforestation forms an interesting part of the education of many Australian school-children. They take an active part in all phases of the work—from the clearing and fencing of the land, to the felling of the timber. Revenue from the sale of timber purchases amenities and educational aids for the schools.

L24-3, (48)

After the timber has been felled and trimmed, the children clear the forest floor, thus obviating fire risk.

AUSTRALIAN OFFICIAL PHOTO.

DARWINISM IN THE MELTING POT

BY SHER SINGH

Which Way Darwinism ? Its Present Position and Some Difficulties,

INTRODUCTORY

It was in 1859— two years after the Indian Mutiny—that Charles Darwin threw a bombshell, as it were, into the world of scientific thought : it was in connection with the "Origin of Species' which epoch-making book has become a big milestone on the march of human thought. Briefly, the two pillars on which Darwin raised his masterly super-structure are the following, namely:

1. There is constant variaiton in the world from father to the children : no two children are alike. Building on this fundamental basis, he argued that some differences are useful to the organism, others may or may not be so. Thus, variety radiated from each parent, and it progressed increasingly downward in all succeeding generations.

2. Side by side with variations, there was another process at work which not only did sorting, but did weeding: this was done by the process of "Struggle for Existence" in which the weakest went to the wall and those that survived were 'presumably' advisedly because Darwin left much to deduction: he enunciated only the broad principles and alluded to some experimentel work but so startling and so catching were these conceptions of gradual progress based on Variation and Natural Selection (as the two principles were technically called) that but a little 'nucleus' was sufficient, and Lo ! a great mass of relevant material came by 'crystallization' of prevailing thought i.e., almost abruptly.

The nineteeth century and a considerable part of the early twentieth century may be strictly called as 'Darwinian', in that people lived on this 'pabulum', and breathed on this 'air'. Even now, Darwin's theory is the backbone of all scientific teaching in schools and colleges. The object of this article is not to detract from the importance of this theory, but to show in what direction the pendulum of public opinion—scientific and otherwise — has swung i. e., moved away from the Classical Theory, in recent times.

So for as I can see, Darwin was not himself an 'atheist' and those that have read the last pages of his book, where he has given some auto-biographical confessions will note his candour when he remarks that his pre-occupation with too much science has 'robbed' from him the pleasure of appreciating Shakespeare and Milton which great works of poetry he used to love in his early life. Like Emerson, he says with much regret, that there are 'compensations' in life: so that what he had seemingly got in one direction, namely in scientific accuracy, as he conceived, he had lost in the other direction i.e., in the sphere of his emotions which were obviously benumbed by these cold generalizations. Not that out-and-out scientists will much regret this change—from which they suffer consciously or unconciously—so long as they hug to their fond belief that they are discovering more and more 'truth' even if they have to surrender all the emotions. Nevertheless, Darwin did harp on this 'change' in his life and I, for one, have been very much impressed by his outspoken utterance of this kind. That alone would be sufficient to give him a great place in the history of Science, for he was a 'psychologist' as much as a scientist *par execellence*—for he observed *also* the reactions on his *own* mind.

Returning to the Evolution Theory, Darwin did not rule out God, in fact, he said that it was a more 'edifying' picture of the processes of Nature, as he said, if evolution were to take place according to the plan he visualised : slow and unending gradual change, then if there was special 'creation' at each and every step, be it man or elephant, the humble bee or an ant. And who can deny that Darwin's well-documented and well graded plan has really given us a cosmoramic picture which few others, in any scientific line, have given? Whether we agree with him or not, to ay, the fact remains that Darwin has opened out to the scientific world another 'Jacob's Ladder' treading on which a scientist may reach 'heaven' to return therefrom, to reach the nadirs down below, and thus go in any direction upwards or below. Indeed, it has become a 'habit' with us all, nowadays, to begin with the history of the subject (whatever it may be) and, thus, provide to readers the necessary *Tableau vivant*— — Living Picture—for proper appreciation of that subject. So, Darwin will live for this 'Darwinian modern-mood' of approaching a problem, if not for his great classical theory.

The first awakening.

Although great credit is due to Darwin for his Theory of Evolution, yet it must not be taken for granted that Darwin was the first and last (if we may say so) propounder of that doctrine. There were so many before him who worked at this idea and gave expression to the same, that one of the writers of an article on this subject in the *Encyclopaedia Brittanica* (who has given a full list of the concerned names) is compelled to remark that even if there were no Darwin, nor his great Classic, yet the world would have had this theory: the great Idea or Conception of Evolution, quite independently of him. The fact of the matter is that Darwin only 'canalised' or 'crystallized' the floating, foggy conceptions which stretch far back to the dim past i.e., to all hoary books of wisdom.

The first 'awakening' (if it may be so called) came when it was found that apart from the continuous variations there were 'discontinuous' ones too, and it is the latter which are really responsible for new departures. In this connection the work of de Vries on *Oenothera lamarckiana* done in 1886 has become equally classical—these novel changes, out of the ordinary, were called 'Mutations'. Althougn Darwin's theory of Natural Selection still remains in the field, more attention has of late been diverted to the mutations for the simple reason that progress of change can be speeded up only by such 'jumps' rather than by slow and smooth variations. To concede this principle was tantamount to accepting 'Discontinuity' in place of 'Darwin's graded Variations' or Continuity, pure and simple, We will return to these again hereafter,

The second Awakening.

The second change came when Mendel, a Silesian monk, published the experiments that he carried on in his own private garden and which related to the hybridization of plants. This work was published in 1865 but "by an irony of fate, Charles Darwin, although a contemporary of Mendel, probably never heard of the problems in which he himself was so interested." It is as well that Darwin did not know of these statistical researches—which have since been recognised as 'Mendelism' and which is the chief technique of breeding today—otherwise Darwin could never have laid the emphasis, he did, so much on the two Principles he had in mind. For, in the first place, it was found that the change was not 'continuous but 'atomic' depending on the 'genes', as they are now called and, secondly, apart from the characters that are apparent on the surface: the dominant ones, there were quite a number that were hidden—recessive—which came up to the surface in cross-fertilization much as some of the ideas submerged in the unconscious self, in the great *libido*, come up to the Conscious Stratum. As to how many characters are thus hidden in the background, no one can say offhand; this can be revealed by constant stream of cross-fertilisation duly and carefully chosen beforehand, as Mendel did. The work of this hidden monk is of as great importance in the field of biology as that of Dalton in chemistry, who is the well known author of the Atomic Theory. Both of these great workers turned our eyes from without to the micro-world within, and it can be said with no exaggeration that it is Mendelism more than Darwinism, which is the cardinal doctrine of the twenthieth century. For one thing, it has given more emphasis to experimental work and it has left the key of research in the hands of actual statistics rather than to vague generalizations. Whether Mendel supplements Darwin or not, this is beside the point—it is enough to state that Darwin's outlook was more philosophical than scientific, but this is not to deny his scientific outlook.

Natural Selection : is it comparable to Artificial Selection ?

'Natural Selection' is based on what the gardeners do artificially in the field. Whether Nature does the same, much as the gardener does with his pruning knife, is at best a guess or a probability, but not demonstrable truth. It is one thing to be sure of any proposition, it is another to know it to be probable enough. Of late, critical students of science have tested the doctrine of Natural Selection and have come to conclusions which are not much in favour of Darwin's theory. I will refer here in particular to a modern book on "The Variation of Animals in Nature" by Robson and Richards D. Sc (first published in 1936) wherein the authors have quoted the concerned paragraphs from the 'Origin of Species' and then conclude:

> "In Darwin's treatment of the subject no proof is adduced that a selective process has ever been detected in nature. Throughout the work such a process is suggested and assumed: its actual occurrence is nowhere demonstrated... .Bateson points out that Darwin originally held that 'individual variation' (i.e., Mutation) was of high importance, but subsequently abandoned the belief. With these minor inconsistencies we need not occupy ourselves. It is far more relevant that, though the importance of Natural Selec-

tion is always stressed, Darwin nowhere suggests that it is the only modifying agency ......He even goes so far as to suggest that the modification of a species may proceed without selection......, for no apparent reason...'..... It is quite clear that he thought that varieties might arise and species might exist without having any special adaptive qualifications. Recent studies have much diminished the value of Darwin's subsidiary hypothesis. Consequently the lack of any clear demonstration that naturally occurring varieties do indeed experience a differential mortality is all the more serious. Tshulock (1922) calls the 'Origin of Species' as 'EIN LOGISCHES MONSTRUM'—(a monstrous philosophy) because it deals with the secondary issue before the primary. It seems to us to deserve this censure far more because it fails to demonstrate the actural occurrence of the process which it seeks to establish as the cause of evolution". (pages 183-184, Longmans).

That may appear to be hard judgment, but it serves to bring out my argument that Darwin's conclusions were more philosophical than based on observations: in this case on true statistics of mortality of the so-called unfit. This is the very crux of the whole problem. In fact, there is no 'demonstrable' Natural Selection, to say the least.

One of the best examples often quoted in favour of this theory is that of Mimicry otherwise called Protective colouring, according to which it is argued that colour fitting in with the background gives best chances of avoiding early mortality i.e. by preying birds and insects. While this theory is quite attractive and is apparently quite feasible, yet some experiments made do not prove that this is really so. Quoting from the same modern book (p. 249) we read:—

McAtee (1932) has made another voluminous contribution to the subject. He summarises the analysis of the contents of 80,000 bird stomachs. ...his conclusions are that *all* types of animals are preyed on in proportion to their numbers.....and therefore conspicuously coloured and presumably protected species actually gain *no* advantage.'! Continuing, the authors give another case, it is the cognate case of protective odour rather than that of colour. They state, with amused bewilderment:" The great extent to which certain groups usually supposed to be distasteful are preyed upon is rather surprising, and cannot but make one hesitate to treat them as specially protected. This is particularly the case in the Hemiptera, where the malodorous Pentatomidae seem to be much eaten." *Hence, it is not right* to adjudge the question without experimental data, and Darwin's conclusions were in many cases quite a *priori*.

A few difficulties : Selection or what ?

I will here take but a few of the many difficulties that stand up, like jutting rocks, in the so-called smooth ocean of Darwinian Selection. To take the simplest case first: let us deal with *mimicry* again :—

(*a*) *Mimicry and Polymorphism.*

The war has, of late, brought out the great importance of camouflaging: imitation of the background colouring, in order to avoid detection. Thus many grass insects are green, and many flower insects are coloured like flowers concerned. The lion is considered to be matched to its somewhat drab surroundings, while the leopard has its coloured light-and shade patterns. All this is claimed to be a result of sustained adaptations and cumulative selection. But on what theory would we explain the long flowing mane of the lion or the horse, or the long white tusks of the elephant, or the antlers of the stag, and particularly that of the reindeer? If protective colouring were all-in-all, such spectacular ornamental colours and coatings will be altogether out of order and will deserve no place in the scheme of protective outfits. Take the blackbird which is black from one corner to the other and yet the bill is golden which does not fit in with the scheme of its colouring but is rather anti-thetical to the whole colour design. Indeed, colours that do not fit in with the surroundings, but are in sharp contrast to the same, are quite un-understandable on this theory of selection. But, they are explained by a completely antithetical theory which in this case is called 'Warning Colouring' i.e., bright colour intended to overawe or to scare away the attentions of others. Is this complementary theory any the more tenable?

Objections have been levelled as much against the 'warning colour' theory as against the homochromatic one. I quote the following two extracts:—

"Heikertinger (1929) has recently considered the case of Hymenoptera, many of which are protected by stings, a device whose protective value can be assumed with greater safety: yet in this group he has endeavoured to show that stinging forms are MORE, rather than less, attacked than other groups" (Page 244, *ibid*).

"Cureot (1921) has objected that diverse noxious forms—toads, vipers, torpedofish—have a homochromatic colouring.

Conversely, we find it very difficult to obtain evidence that the striking or brilliant colours of many English slugs have any 'warning' value . it is difficult to obtain satisfactory evidence as to how far the protective devices of warningly coloured animals are efficacious..." (P. 244, *ibid*).

This is particularly true when the same form has two different colours in the same area—poly-morphism—in which case if one colour is protective, not so the other.

(*b*) *Two peculiar phenomena* : *so easy, yet so difficult ?*

Darwin relied on somewhat random variations for the origination of highly complex structures: all that was necessary was sufficiently long span of time, and the selective sieve of Nature which favoured this, that and all, until the required climax was reached. Now this may appeal to some minds, it cannot appeal to all. Who can believe that the complex organism, namely the human brain, will come into its collective capacity, such as it has, merely by the prolonged process of hide-and-seek, or give-and-take, or make-and-mend whatever you may like to call it. To quote again " the essential feature of the complex organ such as the mammalian eye or kidney is the co ordination into one working whole of a number of separate structures and tissues. The difficulty of obtaining such co-ordination by the selection of random variations in the various parts is sufficiently obvious...

It appears to us that there is a certain danger in assuming that important evolutionary processes are due to a type of variation which is probably never demonstrated " (P 307, *ibid*).

In particular, I may refer to the occurrence of certain beautiful eye-like round patterns that occur on the wings of certain birds, sometimes called 'the ocellated patterns." These patterns give to the possessors thereof a heavenly tinge—hence some birds are called 'Birds of Paradise' for they possess unearthly metallic colourings and weird patterns such as these. How could they have come ?

The Selection hypothesis of Darwin merely explained this (or explained away all beauty !) by saying that some coloured pattern arose, it was then improved upon, until all these geometric patterns, so beautiful and so fanciful, were made! Now, in the first place, all this is so imaginary that it can never be said to have happened ; nor are there intermediate changes and improvements of patterns such as must exist according to this graded theory. But there is another modern theory and which comes very near that what we see. It is like this: if you have a jelly—a colloidal film, for instance, and if in the centre of that we put in a drop of silver salt, and let us suppose further that the original jelly was also impreganated with some salt, say sodium bromide, then we will find that there will be red precipitate (of silver bromide) in the middle, but this is not all—there will be succession of such rings separated by white jelly in between! This pattern of rings was first studied by Liesegang after whom these rings are now called, which are like this:

(((((((((o)))))))))

As to why there is no continuous red colouring but ring-phenomenon is easily explained by the properties of the jelly or the colloid chemistry. Now, if we study the eye-patterns on the wings of birds, we have somewhat similar phenomenon working, producing rings separated by islands of no colouring-all this is understandable enough from the theory of colloids and can be easily demonstrated by experiments. But on the Darwin's fancy-pervaded idea, we go nowhere: we are tied to the pole of 'ignorance' otherwise called Natural Selection.

This phenomenon of the Liesegang Rings shows that the real actor behind working and producing these patterns is the jelly-like protoplasm, which sits behind the veil, but is none-the-less real. The key to variation, therefore, lies in bio-chemistry, but is not wholly confined to that newly evolving Science.

What is true of the eye-patterns can be said with similar significance, to the production of light by gloworms which carry their ever-ready batteries in their own tails ? How did they come in possession of this automatic gear ? Darwin's guess would not explain the how and why of the same, but I can understand the phenomenon better if any body—any chemist—could, at his will, reduce protoplasm to the luminous phosphorus, which it no doubt possesses : here the 'will' of the gloworm brings about this change; this reduction, to produce light !

Some cave insects have lost their eye—just where they needed it most on Darwin's hypothesis. All this shows that there are many other factors than that of seeming selection only. This may be due, as it is sometimes said, by the creature 'voluntarily' selecting such sheltered places due to the atrophy of their eyes already in progress. "If this were true, of course, we would have to look on the atrophy of

the eyes not as an adaptation to the cavernicolous habit, but the latter as an adaptation to the loss of eyes!" (*ibid* P. 271). There is an element of actual 'willing' in this case more than blind adaptation. I will come to this subject again at the end.

For the present it is enough to state that the eye-like patterns on the feathers of the male Argus Pheasant, which Darwin attributed to 'sex selection' are more easily explained by colloid chemistry, and 'the ocelli' themselves could scarcely be said to have undergone evolutionary development at all as Darwin's hypothesis would postulate a large number of intermediaries, which are absent."

The structure of the vertebra, particularly the cup-and-socket arrangement and other close-fitting arrangements, have been like-wise explained by stress-and- strain theory and " it is unnecessary to attempt to explain the adaptations of such structures as due to Natural selection." (*ibid.* P. 272).

Such colorations which look to be so easy, being geometrical, have their roots deep in the nature of protoplasm itself, which is the seat of life and of all mystery. How easy, yet how complex, they must be? The Selection Theory robs them of all beauty and novelty by postulating erring-links which have to die repeatedly before the full-fleged beauty is at its best. All butterflies are a palpable demonstration of the truth that beauty is an initial part of their equipment, the first or basic component thereof, rather than an accretion labouringly acquired after prolonged travail. The chemistry of living protoplasm gives us a deeper clue than the facile assumption of the old biologists i.e., all is sawn, sculptured and embriodered by the same wooden or solid device, namely Selection.

The Extint animals: so big and yet dead!

One more crowning difficulty that may be referred to here is the disappearance of those big reptiles and mammals which were really Herculean in size and structure, and compared to which our elephant is a tiny ant. And yet they have succumbed one by one, and it is now only the rocks hidden which reveal these marvellous denizens of the past, of whom one peculiarity was their colossal proportions. It is difficult to imagine our reactions if any such past creature were to rise up from its grave, as it were, and were to pass by us; would it not be like Lilliput matched against the Himalayan-beasts? When there was no equipment with the former to keep out the whirlwind attentions of the latter!

They were really all flesh and bones, and if mechanical efficiency is all-in-all, as the Selection theory of old posits, then certainly these actors should have been the last to disappear from the scene of their activities. And yet they have had their day, and they are known only by their footprints or half-petrified fossils. It is now said that they disappeared because they did not have much brain as compared with their size, but this cannot be the only reason, as we have many animals, now living, with tiny brain, as the ostrich or the kiwi, or the elephant, to take but a few.

There must be some other reason for their disappeareance, which was somewhat abrupt. It might have been due to cataclysmic changes in the climate, bnt there is probably more truth in the observation that extraordinarily big size is a sign of senescence or of disease: we have similar trouble in man when gigantic legs or feet are developed. This gigantism (acromegaly) is now known to be due to the hypertrophy of the pituitary body as result of which a 'hormone' which acted as 'brake' in keeping the organs in due trim is, thus, removed, so that like the cancer cells, there is unrestrained vegetative growth, leading to this abnormality. This is certainly not due to adaptation or 'selection' but to morbid atrophy of the controlling-brake, whatever its exact nature.

There are many other such 'brake-centres' and the ductless glands are supposed to be particularly active and functional in this respect. Their secretion may be hidden, yet is none the less real. We know of the fatal disease: diabetes which is caused by the atrophy of a part of pancreas. Thus, there is a correspondence between each cryptic-centre and its effect on tissue formation. Indian psychology of old recognised no less than seven-chakras or 'whirling-brakes', and although they cannot be seen with the naked eye, yet they are real enough and there is much truth in the nomenclature (Chakra) for they must be in motion themselves before they can do their work even as a dynamo must be itself in motion to produce light.

The mammoth and the huge reptiles of old must have suffered 'in turn' from this disease: due to the atrophy of their delicate control-centres, and, thus, they attained the 'gigantic' proportions symptomatic of this senescence, and ultimately passed away.

Now to return to the diseases of modern man: they are well given by the author of "Modern Biology" 1928, Cunningham, wherein he says:—

"Three of the most familiar defects of

civilized man are defects of sight, defects of teeth and deficiency of hair. Under the conditions of urban civilized life these defects apparently tend to increase."

To me the most amazing and most serious defect appears to be neither this, nor any other connected with the body, but that which Darwin himself wrote as a result of his self-study, and which I have referred to in the beginning, namely, the atrophy of the Heart of Man, due to his excessive specialization and exclusive cultivation of his brain, insomuch that some 'pineal' gland (?) (if so we may say) is hypertrophied insomuch that all apparatus for contacting the Higher World of Beauty and of Life is lost. It is a death far more vital and far more suicidal than any wave of mortality from which our past ancestors have suffered: for, under this we uproot the most essential apparatus which is that of susceptivility to Higher Vibrations, of which the emotions and impulses are but reflexed-ripples, which would not arise but for this impinging-light from above This may seem to be somewhat mystical, but is not all Science drifting towards some such goal ?

The disharmonies and the snags pointed out above, and which are accumulating every day with the march of Science, are a clear indicator of the fact that Natural Selection does not explain all the facts: it is but a convenient *serai* or halting-stage till the goal is reached and this goal, in my opinion, is deeper and higher than all the conceptions which we can bring together in our usual philosophy—it is coterminous with Life and is, therefore, full of mystery from within and without. Bio-chemistry takes us much nearer than biology, pure and simple, but we require mobilization of all forces—of mechanics, biophysics and stereo-chemistry, including philosophy, for that is the solvent of all differences.

CONCLUSION

In this preliminary survey, I have dealt with some of the 'ordinary' difficulties that do not fit in or dovetail with Darwin's Theory of Selection or Origin of Species. In the second or the concluding portion, I will deal with more outstanding difficulties which are in a class by themselves, wherein the vexed question of 'Acquired characters and their inheritance' will also be considered. I have purposely avoided list of names and long extracts. But, in the end I may quote the following well-known jibe: "Darwinism tries to explain how I am here by showing how my uncles, cousins, and aunts have gone away" in other words, it harps more on the course of Elimination, although Darwin took exception to this term: Natural Elimination, but, if Selection is 'Sieving', and no more, why all must depend on size of the sieve-holes, and the plasticity of the material sieved. Judged by these standards, Darwinism is either too crude or too fine to sieve-out, all Beauty and therewith all mystery!

II

DARWINISM AND ITS THREE HURDLES : BEAUTY ? SPEECH AND THE SUPREME FACT OF CONSCIOUSNESS

SUPER-DARWINISM THE ONLY WAY OUT !

Introductory.

Darwinism is a good servant but it is certainly a bad master. In other words, it is good enough to feed the 'infant mind' in schools and colleges, and there is no very serious objection to that ; on the other hand, it gives the student a fairly good idea of the hard struggle for existence which is everywhere rampant, as much in the outer world, as in the world within. But this is not all. That Nature is not all tooth and claw and pointed beak but something more will be obvious to even the most casual observer. Who has not observed the birds and the butterflies in their best gala dress, and who in his days of infancy, has not had attentions drawn to the flower in the field as much as to the rainbow in the sky, for the two are, as it were, knit by the same Fibre, Beauty self-spun, and self-revealing. The bloom of Beauty is here, there and everywhere, and it needs no fairy-eye to behold the bewitching drama which comes to us with the first kiss of the morning sun and parts not till it has left us with its co-partner the moon, and failing that the stars that twinkle all the more the greater the gloom, and thus bring beauty nearer to us than even in the daytime. Even as the stars do their task high up in the heavens, so also do the flowers, the lilies and the daisies just as much as the sunflower and the lotus, the king of all plants, which remains unperturbed in the ocean of water which is like a mirror to reflect the beauty of this holy Guest above. Nature is efficiency and activity, no doubt, but it is also velvety-beauty, and subdued grandeur which is revealed in lines and in curves, but more particularly in colours and costumes, and above all in changing rhythms which come and go with

the wheeling seasons—and as each season goes, who does not feel the parting-pang, like the streak of gold rubbed on the granite-hard rock of the heart? Oh! there is lingering beauty in every face that we see, in all spectacles that we behold and in all experiences which we so much treasure! Are not the dreams so many repercussions of the scenes that we saw in the daytime, and which willynilly have sunk down into the depths of our mind, to disturb us in our sleep, and to tell us that "Beauty is not gone, it sits with us, and sleeps with us,—This time, on the Pillow of our heart?

There is beauty in the coloured butterflies just as much as in the shells of the sea-shores. And even if the green colour does not strike us very much due to its super-abundance (chlorophyll) yet who does not know that green is the mean, and the meeting point of all colours? —the centre and the *logos* of all spectral colours which are:—

Red, orange, yellow, GREEN, blue, indigo, violet!

The midmost is most essential even as is the human tongue which is the meeting-point of bilateral-symmetry in man and the animals. Beauty is universal, and it is found not only in the living which flit like sparks of light, but also in their surroundings, which harmonies they make naively, and yet with such exquisite architecture. Here, I may quote but one sentence from the beautiful description of this phase from Dr. A. Thomson's Gifford Lectures on "The System of Animate Nature" (1924) wherein he tells us:—

"Now what seems to us to be a fact, and a very interesting fact, is that all natural, free-living, fully-formed, healthy living creatures, which we can contemplate without prejudice, are in their appropriate surroundings artistic harmonies, having that quality which we call Beauty—To many of us—of the eye-minded type—the blotting out of the annual pageant, say of the flowers and of birds, would be the extinguishing of one of the lights of life... ..... When we study the nests of birds, the web of spiders, the architecture of the termitary, the combs of bees, the work of the tube-building worms, the arenaceous encasements of some Foraminifera......we recognise skill .....almost reaching to art......" Who can shut his eyes to this: the omni-presence of Beauty, and, of Design, in Nature, all around?

The first rub.

Darwin had no explanation for 'beauty' as it came outpouring. He had no 'use' for this beauty, i.e., other than the phenomenon of mimicry (referred to before). He rejected all doctrine that suggested beauty for the sake of beauty. "Such deviations, if true" he said "would be adsolutely fatal to my theory." We cannot ignore the overtowering phenomenon of beauty that is patent in Nature, no more than we can ignore one eye as against the other. The cock has some beauty all its own; that of streaked-colours tipped with comb-colouring, on one side, and tail-bunch below. The lion and the horse have their mane more for beauty than for protection. From among the birds, we have green parrots, the yellow orioles, the red sparrows; indeed, all rainbow colourings; until they become really elegant and gaudy such as we see in the pea-cock or in the bird of paradise. There is certainly more than mere camouflage or 'warning colour' in these embodiments of beauty. And the butterflies specialise in colour combinations much as the fireflies do in production of light at night. We cannot explain these phenomena unless we have an eye on the independent occurrence of Beauty, as one of the integeral factors of evolution. Beauty is the golden-thread different from the silken-twine of utility, pure and simple.

Mimicry we have stated does not explain this in full: there is much over and above 'protective coloration', it is a thing of art, as is the peacock. There is wealth of colour and exuberance of artistic patterns which no amount of 'sexual selection' will explain at all. Why, for instance, there should be a dark band round the throat of the parrot, why long streaks on moths! geometrical patterns, such as we have, in many sparrows!—This is a subject far too deep for words.

To take a few specific instances, in the case of Marco Polo's sheep—the Pamir sheep (Ovis poli) the horns are not only big but they are curved in no less than two curves, and it has been well said by competent critics that "the enlargement is far in excess of imaginable exigencies of courtship, competition etc."; and these heavy curls can only be explained on the hypothesis of beauty. Other instances are excessively large and the other is normal.

Or take the case Australian Bower birds which have been specially studied of late (1932 Barett and Grandall). The conclusion reached is that "the character of the 'bowers' made by these and the uses to which they are put seem to be far in excess of the normal requirements of display and courtship and have little relation to the survival requirements of the species" (P. 342, *ibid.*). Or, again, the following observation by Prof. Thomson is very apt and 'shows that there is something more than

mere utility: it is aesthetic-consciousness at work even in the animal kingdom, for as he says: "There are some cases of apparent aesthetic delight among animals, e.g., that of the Bower-birds which decorate their honeymoon-bower with brightly coloured objects, apparently productive of pleasant excitement!

Even if the bright colours of the males in birds be connected with sex at bottom, with some hidden hormone in the background, the fact remains that there is mutual pleasure and satisfaction—more than comes from mere Narcissism—from these gaudy colours. Personally, I think that 'beauty' is more essential than even utility—the former caters for essentiality i.e., transcendental values, and the latter is a device for perpetuation of the species, and what would be one without the other? Mere mechanism and utility would be machine-like equipment, but in Nature we have the two strands interlaced: to the earth and the things earthly; there is also the *complement* of heaven above, and in between the two, there is the visible rainbow: Bridge of Beauty.

There is real 'joy', when the male struts before the female bird and spreads array of its beautiful feathers: there is, on the other side, real coyness and flirtation—these are interlinked and beauty is necessary concomitant of aesthetic emotions which are found at all levels of animal life. Do you think that it is mere 'cheating' which attracts the bee towards a colour, the attraction for honey or for colour which are but undertones for the real music that is cross fertilization?

In my opinion, there are no undertones and overtones—the two functions are on a par, even as the two eyes are sub-serving *one* vision. If you tried to rob the bee the invitation of the colour, as also the interlinked fragrance, you will find that the bee-world will be starved just as much as it would be starved without food. There is some truth in the assertion that the *papiya* is mad, not for ordinary drop of water, but the drop that descends from the heavens for the first trikle of monsoon rain—so, likewise, birds and butterflies have a real hunger for the other-worldly colours without which they will starve just as much.

That there is real hunger for beauty will be evident from the following extract from "Modern Biology" by Cunningham 1928: "The world pleasure gives the key to the nature of music and beauty in general. Beauty is connected not merely with our perceptions, but with our emotions and feelings. And an emotion has been stated, apparently correctly, to be some sensation which affects our principal bodily functions through the nervous system. Pleasure stimulates circulation and gives a feeling of joy in life. "So there is 'hunger of the nerves' to be satisfied just as much as the hunger of the stomach, and the bees, birds and butterflies have both this craving as well as the ordinary one for filling the belly. Continuing he says "There are two ways of considering these responses. We may consider the animal as an automaton, as T.H. Huxley considered the cray-fish. We may conclude that the mechanical automatic response has its counterpart in a state of consciousness—however rudimentary." (p. 223). I have no doubt that there is in the animal kingdom a *real* joy—joy on seeing beauty, be it in a flower, or in their ladylove—there is joy of the same kind, though of lesser intensity, as in man. This should be required on the principle of gradation i.e., of Variations as propounded by Darwin, and it is nothing short of myopia to deny this joy to the lower creatures when we allow this to man, the crown of evolution.

Beauty is, therefore, ingrained in Nature, and there are admirers and connosieurs of beauty here, there and everywhere, all along the ladder of creation. Darwin admits the utility of iron-clad efficiency but denies the embalming material in which the gridiron frame of utility is inlaid: this is like addmitting the existence of body and denying its other partner, the soul. This is then the first 'rub' from which this myopian-Darwinian theory suffers.

The Second Rub: Speecch, Music and Language.

One other fact which looms large in my estimation is the somewhat sudden emergence of powers of speech in man, which has been elaborated into music, on the one hand, and into language and literature, on the other, on whice rests all human culture. If we look down the scale, we do not find anything like this either in the apes or the monkeys, nor in the remote cousins, namely the birds. There may be a little chatter here, and musical twitter there, but what comparison can these monotonous sounds have with a well-modulated speech that we find in man, which is deeper than any other internal possession, next only, in fact, to the mind of man, of which the speech is significant spout or trumpet-triumphant.

We cannot find the intermediate links that we might 'expect' on the Darwinian

theory; there are no steps nor sundry links missing, but no less than six out of the seven spectral colours is missing from out of the gamut of speech. How this may be explained on the theory of Natural Selection is inconceivable?

That speech is one of the most powerful instruments of propaganda will be obvious enough from the loud trumpeting that the elephants make or which the lions do when roaring and even the silent snake 'hisses' violently when disturbed. True, in the case of a snake, the hissing is produced by the rubbing of external scales against the earth, or of these between themselves, which, therefore, does not come from the vocal chords. But, hissing is significant enough and its sudden emergence in a snake is as remarkable as in man. In the cicads and grasshoppers also, there is somewhat external apparatus—a file outfit of scratching and producing strident music. But in birds there is the vocal chord working, as in man, although on a very elementary scale. Nevertheless, it is a fact that the birds do 'sing' and this they do when they are free from all fleshly considerations. I have seen blackbirds, singing every day, early in the morn, when at best and free from all other food engagements—then, they warbled many a nice longdrawn ditty, but as soon as the day advanced, they got down from high perching ground and began to find the worms with ugly shriek here and there. It is, therefore, in the hours of ease and placidity alone, that 'music' outflowed from the hearts of birds. The nightingale does much the same. The cuckoo, on the other hand is wild with some 'craving' which can never be satisfied, for which reason it continues to squeak and cry. There are other birds—some nocturnal ones—that I have noticed which cry out to the mates, repeatedly, but this is done only after the response is made by their mates, hidden in bowers many furlongs away. In this way, they keep themselves in touch, as it were, despite the difficulties engendered by the night. The *Titar* or the portrayed partridge punctuates its work with iterated exclamations, which chant, as it were, the glory of the Maker.

No doubt, there are here and there, all along the animal scale, broken accents or consonants of speech, but there is nowhere that long drawn out connection which characterizes man. There are no intermediate scales or any other significant symphonies. The gorilla does make mouths and make some gestures of pleasure or disapprobation, even that of despondency, at *times, but how different is it from man*, or for that matter even from the birds which can pour their heart by music?

The fact remains that 'Speech' primarily comes into play in man—the broken accents of animals or of birds, if anything, put this contrast into further relief. How did this exceptional development take place, as if by a spurt? This is attributed by one American biologist to 'hand' movements (The causes and course of Organic Evolution: Madfarlane 1918) for, as he states "So the extremely slow but nevertheless steady increase in size of the brain and its weight has, we consider, proceeded with, and been stimulated to growth by, activity of hand and arm as collectors and transmitters of environal stimuli to the brain." (P. 528) But if this hand—, movement is all-in-all in determining speech, surely the wagging of the tail by the dog, and that of the trunk by the elephant should have been equally efficacious, and yet we find both the dog and the elephant so deficient in this power. So the fact remains that speech has an indigenous centre of its own, and it develops most in man, and this has no Natural Selection link with ape—indeed, the link is so attenuated, if any, that it is conspicuous by its extreme tenuity. After referring to the scanty expressions by birds, monkeys, and the hen, for instance, the author himself admits (p. 586) "*But it must be freely conceded that*, so far as directed evidence at present goes, a CONSIDERABLE GAP EXISTS BETWEEN THE LINGUISTIC PERFORMANCES OF THE HIGHEST MONKEYS, AND THAT OF THE UNCIVILIZED MAN AS NOW LIVING......If such be the case some cause or causes must have existed for the advance of man, and for the origin with him, in richest measure, of language..." This origin, in my opinion, does not lie merely in the direction of hand, or that of the eye which sees gestures or mute-symbols of action, but in higher potentiality of man: in other words, in a higher scale of eye and ear, and their correlation with the tongue and the vocal chords, i. e., the co-ordination of the most complex kind, requiring definite pre-vision.

In support of this, I may quote the following, extract from the late Dr. Ernest Neve's brochure on "Some of the difficulties of the Evolution Theory", where he quotes from Colgrave and Short the following about the human Ear—which he read in 1918 to the Kashmir Science Club:—

"In the human ear there is a set of strings of varying length and tension, like the strings of a piano. On each string rests a pillar-like cell

with some stiff bristles at the top, which are embedded in a sort of pad or damper. Each of these cells is connected by nerve fibres with the brain. When the note C is sounded in the outside air, 256 vibrations fall on the drum of the ear. But sound waves have little power behind them; they must be magnified to overcome the inertia of the delicate mechanism of the ear. There is double provision to meet this difficulty; one is an arrangement of levers called the ossicles and the other is a much smaller drum behind the first, so that the nett result is to increase the power sixtyfold. Thus 256 vibrations a second are transmitted to the piano strings of the basilar membrane and the C string vibrates up and down. The bristles are pressed to and fro in the overlying pad and the nerve fibres supplying that particular set of cells signify to the brain that a message is being received from the C string. Once again it is easy to see the beauty and value of this when we are shown the finished article, but it is putting an extraordinary strain on credulity to be sure that every one of the thousands of steps that had to be taken to reach this end result was of sufficient value to the possessor to survive. Enormous advances would have to be made relatively suddenly before natural selection would begin to take care of them."

Continuing they say "Exactly the same objection may be raised with regard to the eye. It is stated that Darwin said that the thought of the evolution of the eye, useless till complete, ALWAYS GAVE HIM A COLD CHILL DOWN HIS BACK. Bergson plainly declares such evolution impossible."

Concluding, "How can the first useless beginnings of complex organs render its early possessor more fit to survive and go on gradually evolving, but still useless; until after millions of years the long chain of defunct ancestors are rewarded by distinct offspring possessing an eye or ear?

It is difficult to believe that every time such developments took place which were just in line with the complex organization required as in case of the human ear or that of the eye. Speech is by far the most complex of all the human features, and this is but a step in the great mystery of human heart of wish consciousness is a still higher reach, as much above, as speech is above gestures, to which we may now turn. No *random* variations can explain this extraordinary advance, in evolution of man and his cousins.

The third rub: Consciousness.

The emergence of consciousness is an extremely difficult problem; as to how the subtle superworld of mind made its origin from the world of matter? It has always been a moot question in psychology whether the mind came from matter or matter from mind. Although there have been distinctive leanings of the scientists towards material beginnings of things, yet the production of atomic energy, on the one hand, and a great many of the conditioned and unconditioned reflexes show that the problem is very complicated. In particular, no amount of theory can explain how the consciousness-of-I, which is special equipment of man, could have emerged unless it was already there—as the basis or the fundamental nucleus of man. Our institution shows that I-am-I is fundamental to ourselves, more than all physical or mental sensations, and if this internal evidence be relied upon, as we must, then 'consciousness' is the very basis of all that is.

With regard to the trend of modern controversy on inheritance of a acquired characters, I must quote the following extract from 'Modern Biology' by Cunningham:—

"We may consider as actual examples of what is possibly firstly such cases as that of the experimental breeding of the American Fruit Fly, Drosophila, by T. H. Morgan, and his school. Most of the mutations recorded have been negative, defects of the eye, wings, and other organs. In some cases there have been positive mutations such as a pair of two wings instead of one; but it cannot be said that there has been much evolution in controlled directions." Indeed all 'mutations' obtained by the use of high-speed articles as alpha rays or nutrons, have been in the nature of 'deficient aberrations' which corresponds to chiselling somewhat of the chromosome block or of gene architecture.

On the other hand, certain experiments done by Prof. Mc. Dougall and of Dr. Kammerer, as reported by Prof. McBride. in the Encyclopaedia Brittanica show that acquired characters are definitely carried down, in some of the subsequent generations. Now much must depend on the nature of the changes and of the degrees of their penetration. It is well known that the old Lamarckian hypothesis of the descendance of ordinary characters is not known to be unsupported by facts. One concrete instance of this is the circumcision, which has been conducted now for well over two millenia, but has not become a fixture in the tribes that have been practising the same. But some violent re-percussions in the genestructure due to altered light conditions or due to other

deep-delving causes have been known to persist; they evidently affect the sex-cells which continue the line. Prof. MacBride was one of the few solitary supporters of this theory in England and such neo-Lamarckians are generally conspicuous by their absence, but all experiments on eugenics are based on the observation that there is something that does descend from the father to the son, which is I believe, the mental outfit, the degree of efficiency of consciousness apparatus—were this not so, the science of race culture, and of correct breeding, will be more or less doomed.

I for one, attach great importance to the dying declaration of a British Scientist, an F.R.S. who declared before his death "Acquired characters must be inherited, must be inherited, must be inherited!" — this is described at length in one of the pamphlets written by another F.R.S. (Prof. Barker) wherein modern 'atheism' is very much deplored. To me, one thing seems to be certain; in man, what is inherited is the mental outfit, and that it is in this way that all evolution occurs, i.e., by the mental accumulation of race momentum from one stem to another. It is in this way that step-by-step progress is made permanent. So that while individual apparatus may not be changed, yet the race—pattern does change with the accumulation of race-knowledge; and the race has its reflex in individual efficiency from line to line. No experience is, therefore, ever lost; it is treasured in the sub-conscious complex of the human mind. The outer appratus, the human body, may remain what it is from age to age, yet, its internal make up changes with acquisition of experience, which inheritence does take down to come up, at suitable time, in the line of descent, as racial heritage never to be lost, or to be brushed aside.

As to whether we can, at our will, induce 'useful' mutations will ever remain an attractive problem; I, for one, can see great changes wrought by high-power particles such as by the impact of say the 'cosmic radiations' or by other high power radiations; then man will have only to pick and choose as to which 'chippings' or 'reorientations' suit him. But that method of chemistry cannot be predicted or prophesied beforehand. The mere fact that we can unmake the chromosomes or genes (as we have done in the case of the fruit fly) shows that by the manipulation of Colloid Chemistry— especially the use of stereo-chemistry— much can be done to alter the transmitting chromosome complex. But that does not rule out Higher Power which brings about such changes already at the opportune time in the subtle evolution of man; the two processes are complementary.

I therefore feel that there is great truth and hope in following the neo-Lamarckian path, rather than in following the strictly mechanistic hypothesis either of utter agnosticism or that of utter denial. The Hindu theory of Karmas is also based on the carrying forward of all experiences, and if this is true of man, as I believe, why not so in the case of lower animals? After all, all life is chipped out from the same Basal Block; you may call this protoplasm, but I will call it Mind Divine, the Cosmic I, from which all that is proceeds ever and ever—rising from one terrace to another, and ever upwards—which is the keynote of the theory of EVOLUTION.

BOTANICAL NAME CHANGES

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There is a common but erroneous idea that Botanists have as their main object the upsetting of established names. Paradoxical though it may seem, changes in scientific names are designed to achieve stability. As is well known our binomial system of nomenclature for higher plants (viz., calling a plant by its generic and specific name) was started by Linnaeus in Species Planatarum in 1753 and the principle of priority is that the first validly published name for an organism is the one to be used. This principle is perfectly sound in theory, but its practical application is complicated by the fact that many names published in obscure journals are not rediscovered until years afterwards, when well known names may have to be rejected in their favour.

The present rules for regulating nomenclature have come into being as the result of collaboration between botanists all over the world. Whether every one agrees with the wording and provisions of the rules or not, these rules represent a very great step forward in the right direction. The rules were particularly necessary in respect of those species which usually have a very wide range of distribution. An example of this will suffice. *Cynodon dactylon* (L.) Pers. 'dub grass' which occurs all over the world. has been given at least 23 different names. Is it better to frame rules by which this grass will have one name only, or leave matters whereby it has 23?

It may, however, be pointed out that the International Rules of Botanical Nomenclature permit the conservation of well-established generic names under certain conditions; but proposals to conserve specific names have always been defeated in the past, particularly because the number of names submitted for conservation was so great, and some of the cases made for the retention of names so weak, that the International Botanical Congress which was held at Cambridge in 1930 and at Amsterdam in 1935 decided against the conservation of specific names.

As it appears to be unlikely that future considerations will lead to any alteration of this decision, it is now wise to accept the position and bring up the younger generation of foresters and others interested in the cultivation and management of trees in the use of the correct names, even though they may create difficulties for older people. In fact the 6th (and last) International Congress of Botany at Amsterdam in 1935, on secret ballot, defeated a motion for "nomina specifica conservanda" (conserving specific names) by 208 votes to 61.

The conservation of a specific name would mean fixing the rank and genus of the plant concerned, regardless of the subsequent research, which is incompatible with scientific taxonomy. On the other hand, a suggestion emanating from the Royal Horticultural Society of London to legalize the rejection of certain specified names may contain the germ of an idea which is workable and would achieve the same result in practice. The not

unnatural desire of the forester and the economic botanist to have one name only for any one plant is likewise incompatible with progress in taxonomy. A plant can have as many names as genera in which it has been placed, Genera may be split up into smaller genera or may be combined into larger genera: or a species may be reduced in rank to that of a variety. Homonyms provide another reason for change: sometimes it is found that the name of a well-known plant has previously been applied to some other species; a change must therefore be made.

To try to fix specific names it has often been proposed that standard lists of conserved names should be prepared. But it should be understood that no standard list can prevent changes of names caused by changes in classification.

It may not be generally known that the Sixth International Botanical Congress, in 1935, as a practical alternative to conserving specific names, adopted a motion that an International Committee be appointed to draw up a list of names of economic plants according to the International Rules and that this list may remain in use for a period of ten years. No such list (an obviously gigantic task) appears to have been completed and published.

The above discussion will serve to clarify the distinction between name-changes due to advances in taxonomy and those due to conventions such as the law of priority. No responsibile body of biologists would seriously propose to limit improvements in classification by permanently stabilizing scientific names, though many would wish to see more careful consideration on the part of taxonomists before upsetting established names by minor changes in the rank of important economic plants (and animals). Admittedly, the herbarium worker, dealing with very large numbers of specimens and continually striving towards the ideal system of classification, does not always appreciate the trouble which name-changes may cause to foresters and economic botanists concerned with a limited number of species. At the other extreme, the applied biologist, the forester and still more the farmer or timber merchant trying to take an intelligent interest in the scientific aspect of his work, often fails to realize that a name is something more than a label, and condemns the name-changer as being uncompromising, academic and out of touch with realities.

It is true that there is a strong case to be made against name-changes which do not signify any progress in taxonomy, as when the resurrection of a prior name invalidates a well-known and old established name. In this connection it may be worth while to compare the merits of the International codes of nomenclature for the two sister sciences viz. Botany and Zoology with respect to this problem. The Botanical Rules provide for the conservation of generic names to avoid disadvantageous changes in nomenclature which might result from strict application of the Rules, but they do not permit of conserving specific epithets. Zoologists are perhaps more fortunate in that their standing International Commission on Nomenclature has plenary powers to suspend the rules in cases where their strict application would result in greater confusion than uniformity.

While supporting the claim that stability in nomenclature is incompatible with progress in taxonomy and realizing that it is impracticable to stabilize scientfic names permanently it is yet possible to minimize the risk of confusion by following some standard work of reference. For example it may be open to any author of a paper or text-book to say in his introduction that he is using the name in the nth edition of such and such a standard work. Furthermore changes due to the principle of priority can be restricted, either by introducing a time limit for reviving of an old name or by amending the rules so as to allow of the rejection of names which are clearly undesirable.

Although the familiar names of a great number of Indian plants have undergone name changes I do not propose to give a list* of them here but will first explain how a new name is arrived at. For this purpose I have selected as an example the case of 'Sabai' or 'Baib' grass which is, I believe, known to most forest officers and others in India as it is economically very important and a source of considerable revenue. The correct name of this grass is *Eulaliopsis binata* (Retz.) Hubbard. It will probably be of interest to know how this name has been arrived at.

This grass was first described by Retzius in 1789 as *Andropogon binatus* Retz. In 1833 Trinius again described it, obviously being unaware that Retzius had already given it a name, and called it *Spodiopogon angustifolius* Trin. When Hackel wrote his celebrated monograph on the *Andropogoneae*, he reduced Trinius species to a species of *Ischaemum*, calling the new combination *Ischaemum*

* A list of name changes in important Indian plants will be published elsewhere.

angustifolium (Trin.) Hack. Neither Hackel, nor Hooker fil., the author of the monumental Flora of British India, who followed him, was entirely satisfied with the inclusion of this grass in the genus *Ischaemum* and it is not surprising therefore that subsequently a genus was created to accommodate it. Unfortunately, however, two astrologists, independently, put forward new generic names. The genus proposed by Stapf on 28th March 1924, was called *Pollinidium* and became accepted in India through the combination *Pollinidium angustifolium* (Trin.) Haines, published it in Haines' Flora of Bihar and Orissa. Incidentally Haines overlooked the fact that Retzius' epithet, *binatus*, was earlier than Trinius' *angustifolius* and should have had priority. C.E. Hubbard in 1932 recognised this and published the new combination *Pollinidium binatum* (Retz.) C. E. Hubbard. Honda, a Japanese botanist, had, however, proposed the genus *Eulaliopsis* in the Tokyo Botanical Magazine on the 20th March 1924, just 8 days previous to Stapf's *Pollinidium*!! When Honda made the new combination, however, he called the grass *Eulaliopsis angustifolia* (Trin.) Honda, overlooking the priority of Retzius' specific name. C. E. Hubbard put this right in 1935 and the grass is now known as *Eulaliopsis binata* (Retz.) C E. Hubbard.

The following is, in short, the nomenclatural history of the grass:—

Andropogon binatus (Retz.),, Obs. V. (1789) 21.

Spodiopogon angustifolius Trin. in Mem. Acad. Petersb. ser. 6, II (1833) 300.

Ischaemum angustifolium (Trin.) Hack. in DC. Monogr. Phau. VI (1889) 241.

Eulaliopsis angustifolia (Trin.) Honda in Tokyo Bot. Mag. XXXVIII (1924) 56.

Pollinidium angustifolium (Trin.) Hainse, Bot. Bihar and Orissa (1924) 1020.

Pollinidium binatum (Retz.) C.E. Hubbard in Kew Bull. (1932) 72.

Eulaliopsis binata (Retz.) C.E. Hubbard in Hook. Ic. Pl. sub tab. 3262, August, 1935.

This is a very exceptional case and it is unfortunate that the grass concerned is one that is known to most forest officers and others in India. They have, however, this consolation that they have not had to learn all the seven names, and having learnt *Eulaliopsis binata*, they are not likely to have to learn any other name for this species.

I give below a short list of name changes, which had to be made in the light of International Rules of Botanical Nomenclature and have added a few notes in explanation where necessary. For the sake of convenience the list has been arranged alphabetically.

Madhuca bourdillonii (Gamble) Raizada comb. nov.

Bassia bourdillonii Gamble in Kew. Bull. 1921, 121.

Madhuca microphylla (Hook.) Raizada comb. nov.

Bassia microphylla HK. in Hook. Ic. Pl. t. 74 (1837).

The genus *Bassia* Koenig (1771) of the family *Sapotaceae* is invalidated by *Bassia* Allimoni (1766), a genus of the *Chenopodiaceae*. All the species hitherto known as *Bassia* have, therefore, to be transferred to *Madhuca* Gmelin.

Phaeneilema hallbergii (Blatter) in Journ. comb. nov,

Aneilema hallbegii Blatter in juorn. Bom. Nat. Hist. Soc. 33 (1928) 74.

Phaeneilema malabarica (Linn) Raizada comb. nov.

Tradescantia malabarica Linn. Sp. Pl. ed. 2 (1762) 412.

Commelina nudicaulis Burm. f. Fl. Ind. (1768) 17, t. 8, f. 1.

Commelina nudiflora Linn. Mant. 1 (1767) 177, non Sp. Pl. (1753)
Aneilema nudiflorum R. Br. Prod. (1810) 271.

Aneilema malabaricum (Linn.) Merr. in Phillip. Journ, Sci. Bot. 7 (1912) 232.

Bruckner in Notizbl. Bot. Gart. Berlin, 10 (1927) 56, made the new combination Phaeneilema nudiflorum Bruckner. This, however, is no longer tenable as Aneilema nudiflorum R. Br. Prod. (1810) 271 is based on Tradescantia malabarica Linn. Sp. Pl. ed. 2 (1762) 412 as shown above.

Phaeneilema pulneyensis (Fyson) Raizada comb. nov.

Aneilema pulneyensis Fyson in Kew Bull. 1914, 332.

Phaeneilema rigidum (Blatter) Raizada comb. nov.

Aneilema rigidum Blatter in Journ. Bom. Nat. Hist. Soc. 33 (1928) 73.

Phaeneilema siennea (Blatter) Raizada comb. nov.

Aneilema siennea Blatter in Journ. Bom. Nat. Hist. Soc. 33 (1928) 75.

Syzygium assamicum (Biswas et Purkayastha) Raizada comb. nov.

Eugenia assamica Biswas et Purkayastha in Kew Bull. 19`8, 262.

Syzygium bracteatum (Willd.) Raizada comb. nov.

Myrtus bracteata Willd. Sp. Pl. 2 (1800) 969.

Myrtus ruscifolia Wild. l. c. 970.

Myrtus latifolia Heyna ex Roth Nov. Pl. Sp. (1821) 232.

Eugenia bracteata Roxb. Fi. Ind. 2 (1832) 490.

Syzygium cyanophyllum (Kanjilal et Das) Raizada comb. nov.

Eugenia cyanophylla Kanjilal et Das in Assam Forest Rec. (Bot.) 2 (1937) 12.

Syzygium kanarensis (Talbot) Raizada comb. nov.

Eugenia karanensis Talbot in Journ. Bom. Nat. Hist. Soc. 11 (1897) 236.

Syzygium roxburghianum Raizada nom. nov.

Eugenia lancaefolia Roxb. Fl. Ind. 2 (1832) 494.

Since Syzygium lancifolium (Miq.) Merrill et Perry (Memoirs American Acad. Arts and Sciences 18 (1939) 196). is based on Jambosa lancifolia Miq. the epithet lancifolium is preoccupied; hence a new name is necessary.

Basic principles of scientific forestry, silviculture and protection, (a talk given to the probationers of the Indian administrative service.)

By Jagdama Prasad,

Deputy Conservator of Forests,

On the 6th of September 1948.

G/110/Gn.—Silviculture is defined and its scope outlined. The nature of experimental research is explained and the law of the minimum illustrated. The importance of genetics in forestry is emphasised. The recognition of forest types, the choice of species, tolerance of species and reproduction are subjects of high importance. Protection is next dealt with and the basis of thinnings is examined. Details of regeneration work are highlighted.

Silviculture is the art of growing tree crops and tending them till they are ripe for the axe, for final harvesting. To have a firm foundation, silviculture and for that matter any art must be based on science.

In the early practice of any art, science may be altogether lacking. That has been the case with silviculture in some instances. In India, to give you an example, it was held that bamboos must be felled during the waning period of the moon, to minimise attack by the *ghoon*.

Scientific investigations have disproved this. It has been found that attack by the *ghoon* is correlated with high starch contents of the bamboo. The starch content is, however, the lowest in bamboo, during the period between the end of the monsoon and the end of December, in western United Provinces, a little later, that is to say from the end of October to mid-January in the Punjab, the cold weather in the south of India and so forth. Similarly in Europe, in the middle ages, that is to say the period between the fall of the Roman Empire and the fifteenth century renaissance, it was believed that light coloured woods must be planted in the waxing of the moon and dark coloured woods in the waning of the moon.

The difficulty is that their is no known single science, in the popular conception, that can supply the basis for the practice of silviculture. Science basically, however, is systematized knowledge. Knowledge is an accumulation of facts and science the classification and organization at these accumulated facts. Silviculture must therefore be based on scientific data relating to the response of trees to all their environmental factors. This sciene is called SILVICS in America, and silvicul-

tural characteristics of tree species by others.

Experimental research in forestry is a comparatively modern development, because trees have long lives and results of silvicultural research take correspondingly long to obtain, measured in periods longer than the life span of individuals engaged in the work.

The bulk of forestry, practice even of to-day is thus based on knowledge derived from observations and I for one believe that while refinement and improvemt lie with results of scientific research, conducted on up-to-date statistical methods, the main source of our knowledge of tree crop behaviour is and will for long continue to be observational data. A friend of mine who is the head of the forest department in a province puts this succinctly by his advice to young forest officers to regard successful forestry as more the product of their boots rather than of their brains. Though examples tend to give a disproportionate emphasis, there is nothing better to fix the burden of a theme. I therefore take the liberty of quoting an instance to illustrate this point there.

Some of you might have heard of a tree called *Dhaura* in the south and *Bakli* in the north. Its botanical name is *Anogeissus letifolia*. The minute dry fruits of this tree, crowded in globose heads, were stated by TROUP in his book "Silviculture of Indian Trees" as O.15 to O.25 inch in diameter. How remarkably accurate this figure is, will be seen from 14 years' records of the Forest Research Institute experiment, according to which the size was found to be from 0.1 to 0. 25 inch in diameter. TROUP further stated that the seed weighed about 3C00 to 3500 to the ounce. 48 independent seed weight tests for the purpose gave the figure as 3850 plus minus 115 seeds per ounce. It will be seen that observational data are not a bad substitute for scientific data, until the latter are obtained. In the forest complex it is impossible to fix upon a particular factor as all important, and an omnibus collection of facts is essential.

Now I am going to refer to the law of the minimum, from which we learn two main lessons for use in practical silviculture.

The first is that when we are confronted with the complex mass of factors that are integrated to produce a certain growth or yield at a certain site, it is helpful to look for limiting factors. By modifying these the greatest change can be effected with the least amount of change in the causative factor.

The second lesson is that unit change in a given factor does not always produce the same effect on the plant. It depends upon how nearly limiting that factor is and with what other factors it is associated. In other words X may be a limiting factor in one case and not so in another. For example.

(i) Increasing light intensity in forests already rather open or thin crowned should not effect the growth or reproduction so much as a unit increase of light in a forest initially dense and dark.

(ii) Increasing temperature near the latitudinal or altitudinal limits of trees should be very effective. But increasing moisture in regions of plentiful rainfall should give little perceptible change.

The law of minimum postulates that effectiveness of a factor depends upon the decrement from the maximum. If we have 5 operating factors, A. B. C. D. & E. in a forest growing on a certain site, and if the amount of A is 20%, of B 30%, of C 90%, of D 60% and of E 99%, of optimal intensity, then while increasing any of these factors to a point nearer the optimum will result in an increased crop, a unit increase say of 1% in factor A will be extremely effective. In the case of B 1% will be also effective, but it will be very ineffective in C, slightly effective in D and practically of no value in E.

To point out the vast complexity of the interacting environmental factors I will now give an example from the field of genetics. There are those who have been impatient with what they regard as lack of genetic research in forestry. As an example a typical European experience may be cited. Scotch pine (*Pinus sylvestris*) is widespread in northern Europe and decidedly variable in its range. Parenthetically I should like to remark that forestry is apparently more advanced on the continent of Europe, but it is not emphasised that Europe has only about five species (Scotch pine, spruce, fir, beech and oak) whereas India has not less than a thousand important species awaiting development. Now for many years European foresters have tried to isolate geographical races of Scotch pine, especially for straightness of bole and rapidity of growth. In a case, seed from Belgium, the Palatinate, Brandenburg and France was sown side by side in Hesse and Brandenburg. Well-defined differences in growth rate resulted, but they were not the same in both the places. If the best is regarded as 100%, in Hesse the results were: Belgium 100%, Palatinate 94%, Brandenburg 82%, and France 77%. In Brandenburg

they were: Belgium 84% Palatinate 72%, Brandenburg 100%, and France 52%. Evidently inherent vigour, which may be conceived to be a definite genetic factor in each lot of seed, was enormously affected by the environment in which it was grown, and differently in each case. This shows that inherent characteristics are far from being absolutely fixed. Their expression is more or less sharply limited by environmental factors.

This instance has been given not to discourage genetic research in forestry, but to indicate the different setting in which it has to be carried out to be useful to forestry and silviculture.

On the positive side, with the same species we have convincing work with broad-crowned and narrow-crowned forms, where progeny from the former showed a distinct tendency to more rapid height growth.

Our work in India with the teak seed of various origins is perhaps similar to that of the regional seed progeny of Scotch pine. The forester of course with less spectacular efforts is isolating desirable strains, for relatively immune groups of species from mistletoe injury, browsing injury, and eliminating trees that fail to go into their winter rest early enough, or others that come into activity too early in spring as a protection from frost and so forth.

Before I leave this topic of genetics I should like to refer briefly to the case of teak suitable for growing in frosty areas. Here at Dehra Dun, we tried seed from all-India and Burma. We recorded failure, and yet you will notice we have some groups of healthy teak. All these are from teak seed from upper Burma, which is in the sub-tropical zone. Even in these groups we had failures, but from a different cause, which was a phenomenal snowfall of about 3 inches in 1945. I can confidently recommend teak plantations in frost liable areas from upper Burma seed and our small groups may in time become the source of seed supply for such a purpose.

I will now tell you something about forest types. Before any work can be designed or attempted it is essential to know what the subject is. Silvicultural prescriptions naturally have to be related to the units of forests, which are named forest types. It is not only necessary to know the type of vegetation that exists on an area but the effect of the environment as well. Left to nature undisturbed vegetation develops towards what is the best permanent type for it. A certain species may be found on a slope and again lower down conditions may become favourable, because of some other factor, for its existence. A student of nature will proceed to analyse these factors and then decide the species suitable for the area. The forest officer in the past has mapped areas containing the same type of vegetation and arguing on the actual existence of the type in each locality as evidence of its suitability grouped all these areas under the same type for similar silvicultural treatment. The forest officer's outlook has also been largely influenced by economic considerations in highlighting species in demand.

While the general outlook of the silviculturist and the plant ecologist is the same, the linear survey of former being the opposite number of the transect of the latter and the sample plot of the quadrat of the ecologist, in certain cases the grouping in one category necessitating similar treatment has led to difficulties in regenerating the forests, which the forest officer has promptly set about to remedy by emphasising the ecological approach. In other cases, due to the greater emphasis on the aspect of economics, he has cut the gordian knot and gone in for artificial regeneration work, in which the *Taungya* system has come to his help in reducing the cost of the operations, and helping to grow more food at the same time.

The object of typing vegetation is primarily for purposes of management in forestry, which is outside the scope of our present subject. But quite a number of our silvicultural purposes are served thereby.

When you have mapped all the vegetation you can proceed to determine the optimal region for a species, or its ecological amplitude. The silvicultural importance of this is very great, in the selection or choice of species for growing in an area.

The theoretical regions have been put into five classes. Within the natural range of a species we have of course the optimum, in the centre of the scale. Above it is the region cooler than the optimum and below is warmer than the optimum. Two more are recognised, where the tree may be cultivated, above in the cooler than the natural range and below in the warmer than the natural range.

MAY BE CULTIVATED
COOLER
OPTIMUM
WARMER
MAY BE CULTIVATED

The rapidity of growth in the first third of life of a species rises in a region what is warmer and continues to be higher if warmer than the natural range for the species. With the approach of the second half of life the rate is the greatest in the optimum. This principle is employed in forming mixed crops.

If two or more fast growing species not too dissimilar in their requirements are grown in mixture, the one which is in a region warmer than the optimum will grow most rapidly at first. At the second half of its life it will slow down and the species that find its optimum in the place will speed up. But if the first is in a region cooler than its optimum, it will probably be crowded out.

Another matter that is of interest in connection refers to tolerance. Tolerance is the capacity of a tree to develop and grow in the shade of and in competition with other species. Now the warmer the climate, the more tolerant a tree becomes. A species which in its climate optimum is an intolerant tree can become half tolerant in a warmer climate. A tree which is tolerant in its optimum may become half tolerant in a cooler climate.

The great advantage of studies relating to tolerance is in reproduction of a species. Lack of light is not the sole factor in inhibiting regeneration, rather lack of soil moisture and or soil nutrients may be the factor with the greatest decrement from the optimum and the law of minimum if followed with discretion may result in success. This can be tested by trenching under a top canopy to eliminate root competition for soil moisture and nutrients.

The time of harvesting mature timber is one of satisfaction to the owner of the forest, but of grave concern to the silviculturist, who has to secure reproduction of the stand.

Reproduction methods are many, but conform in principle to a few standard ones, of which they are modifications. The aim in the method of cutting the forest is to produce such conditions as will favour reproduction of the desired species. The silvicultural systems are divisible into two main catagories, one called hign forest systems in which reproduction is mostly aimed at from seed and the other coppice systems in which forests originate mainly from coppice shoots and suckers. The selection of the appropriate system is a highly skilled job and the implementation of the prescriptions one of equal merit. In both these matters the skill of the forester is in direct proportion to his acquaintance with the knowledge gained from text books.

Every teacher of siviculture therefore rightly emphasises the fact that silviculture cannot be learnt from books. A subjective outlook in the practice of forestry is to be guarded against, specially. General rules and principles are only a guide for every species and every environment are laws unto themselves. Nature follows laws, it is true, but our postulates are erroneous generalizations regardless of the objective approach that is the secret of success. The oldest forester is everyday learning things about the behaviour of plant species by observation and experimentation. Of course the chief reason is that static laws derived from the allied sciences cannot be applied straightway to dynamic conditions. A change in one factor brings in a corresponding change in the others.

The answer to the question "if I prescribe such a treatment and such a regime of thinnings for a forest crop what will be the result", is to be sought not by reasoning alone, but by going out to the forest and learning what actually happened, when the forest has been treated in the same or nearly the same way.

We shall now consider briefly the silvicultural aspects of the chief causes of disease and injury in respect of protection of forest crops.

The natural life span of trees varies with species running say from 80 years to over 9000 years in the case of the sequoias of America. Individual records show that a red cedar has attained the age of 4000 years. As in scientific forestry trees are exploited before their physical age the question of special measures of protection does not arise.

In the case of injury from high temperature which occurs with long exposures to temperatures between 110 and 120 degrees F, although injury takes place in a matter of a few seconds with a temperature of 130 degrees F., trees with dark coloured bark are the most liable and can be protected by shade during the middle of the day. In the case of injury to seedlings, if it is due to the character of the soil, this must be changed. Some seedlings are liable to provide

their own shade and in case of transplants, as seedlings with large stems are less seriously injured, plants of proper size should be put out in such cases.

Damage from low temperatures, surprisingly enough, occurs more severely near the warmer limits of the range of a tree than the cooler limits. But this is because in these cases the tree starts its growth too early in the spring. Trees at the colder limits also are damaged by early frost, when they continue their activity very late. To combat this form of injury various silvicultural devices are practised, such as selection of frost hardy races, drainage of frost hollows, etc.

Injury from lack of soil moisture is common in the case of seedlings, but occasional droughts at long intervals affect larger trees as well. Selection of draught hardy species is the usual course for localities where phenomenal damage of the latter kind occurs. Various devices can be adopted successfully in the case of seedlings.

Protection from fungus, insects and browsing animals are specialised branches. The silviculturist aims at keeping the crops healthy and in a thrifty condition, as a measure of protection. Genetic research is also expected to help in control by the discovery of resistant varieties.

The prevention and control of fire are almost entirely a matter of protection, in our country, by rules and legislation. Fire is, however, also used as a help in regeneration operations.

In this connection I must say a little more about thinnings, as they help very much in keeping a crop healthy and thrifty and thus aid very much in protection. A thinning is a cutting made in an immature stand of trees for the purpose of increasing the rate of growth or improving the form of the trees that remain and increasing the total production of the desirable form of the outturn.

A tree grown in the open produces a greater amount of wood than a tree of the same species grown in the forest. But we do not want the greatest possible volume per tree. The bole of the tree grown in the open is short and a large percentage of the volume is in the branches which are not so valuable; besides the tree occupies a comparatively large space. We want the largest number of trees per acre that will grow with the best form and speed. Competition in the crop is so keen that the forester must interfere, however, to help in maintaining the optimum number of trees per acre to satisfy all the objects set out by the owner of the forest.

In contrast to the single tree standing in the open we have the classical example of a *Pinus contorta* (lodgepole pine) stand in the Rocky Mountains, where there were 101,000 seventy year old trees per acre of not over eight feet in height. Such stagnation completely ruins the stand.

Given the same climate, the same soil and moisture, growth of trees will be largely governed by the amount of nitrogen in the soil and the ability of the trees to make efficient use of it.

Now this nitrogen supply of the forest comes for the most part from decomposition of the organic matter on the forest floor. There are other sources of nitrogen, but they are practically fixed throughout the forest and are not in any way affected by the density of the crop. But the release of nitrogen from the forest floor also requires time and thinnings help to bring about increased crown development together at the same time as the increased nitrogen supply. That ought to be the basic principle for devising the best method of thinning.

After this brief introductory account perhaps you will be interested to get acquainted with a little more detail about some of the things that have been said here in a general way. As I have said before, there are two ways of regenerating the forests, one is natural and the other artificial. Because of the more popular nature of the latter I will tell you something about the artificial regeneration of forests here.

Artificial regeneration is being resorted to in our country's forests for sal (*shorea robusta*) in Bengal and the United Provinces, for teak in several provinces, and in afforestation and re-forestation schemes in various parts of the country and for the introduction of valuable exotics.

The most important question to be tackled in this subject is the choice of species that will prove a continued success on the area to be planted up. The usual criterion in this respect has been the similarity of the climatic and edaphic factors of the new site to that of the natural habitat of the selected species.

We have accumulated experience from which lists of species have been compiled of species suitable for special sites. For example

draught resisting species include *Anogeissus latifolia. Acacia arabica, Acacia catechu, Eugenia jambolana.* etc.; species suitable for sandy soils are *Casuarina, Dalbergia sissoo*; those for saline soils are *Acacia arabica, Butea frondosa Acacia catechu* ; for swampy sites *Eugenia jambolana, Butea frondosa, Eucalyptus robusta* and for frosty areas *Dalbergia sissoo, Morus alba, Pinus longifolia, Zizyphus jujuba, Dendrocalamus strictus, Acacia catechu, Aegle marmelos* and so forth.

The rainfall limits of species place a severe check specially for dry areas below an annual rainfall of 20 inches. Once you are in the 20 inches and over rainfall belt the establishment of plants without irrigation is comparatively easy. Perhaps the limit may be lowered slightly, because the requirements of plants in the temperate regions are somewhere in the neighbourhood of 6 to 7 inches and of double that amount in the tropics. However, a subjective decision is erroneous and actual trials are the only safe guide.

The temperature limits are also used in fixing the suitability of a species for a new site. For this pursose the mean temperature figures of the original home of the plant have been found to be unreliable and two more statistics have been tried successfully in Australia, called the amplitude and the phase. I am at the moment engaged in determining these values for some of our Indian stations, but the work is progressing very slowly for I have found that the step in the calculations of these values requires the fitting in of a Fourier's series in the data of monthly averages with the use of solar radiation figures, which are not available for the stations.

The next step in artificial regeneration work is the method of stocking the area. There are three main ways of doing this, that is to say direct sowing, transplanting, and stump planting. Direct sowing needs no explanation. Transplants are obtained from plants raised in the nursery and are usually three months old at the time of planting. Stumps are obtained from nursery plants that are about a year old, the stumps being obtained by cutting off the shoot of the seedling to $1\frac{1}{2}$ inches of its length from the collar and cutting off the root to 9 inches of the root from the collar. Results of experimental research furnish information as to the best method of stocking a particular species out of these three methods of stocking.

The treatment of the seed of species is another subject of great importance. You have probably seen the fruits of ***harra*** (*Terminalia chebula*). If the fruit is planted with the pulp on germination is poor, but depulped it gives a very satisfactory per cent of germination. The time of collection of the fruits is also of great importance. In the case of this very species we have found the first fortnight of January as the best time, which surprisingly agrees with the much earlier findings of Puran Singh (Chemist at the Forest Research Institute) that the best tannin content is also found in fruits collected at the same time of the year.

All these points of detail need accurate determination by research. Even the time of sowing of the seed, in the case of direct sowing of the seed, specially, needs accurate determination for some species such as *Pinus longifolia.*

Plants in some respects are the most fastidious of living things. Here at the Forest Research Institute experimental garden we have a plot under the *Casuarina* where a single plant of the kudzu (*Pueraria thunbergiana*) prospered growing and covering an area of 25 ft. in the course of a season and yet hardly a furlong due south failed to grow under the Tung (*Aleurites fordii*).

For field work accurate information of this nature makes the difference between success and failure. In the planting of the black wattle (*Acacia mollissima*) sowing of the untreated seed might be written off as a failure, but if the seed is dropped in water brought to the boil and kept in it for 12 hours, it develops a mucilage. This if washed carefully and the seed cleaned and dried gives a very good percentage of germination; such seed after treatment stored for six months and sown thereafter gives a better performance.

That, in brief, is a glimpse into the basic principles of forestry, silviculture and protection. My hope is that you have not found me too boring.

Effect of burning on the soil as affecting artificial regeneration.

NATURE OF THE PROBLEM

To elucidate the relative effects of burning itself as distinct from ash, an experiment was started in 1938 in the Experimental Garden at the Forest Research Institute, Dehra Dun, in which four different treatments were compared. That led to an experiment with a more elaborate lay-out in the following year. But of these we shall have the details later. The scope of the problem is considerable, as results can not only be of direct benefit in artificial regeneration work, but also in solving allied problems of natural regeneration of important species. The immediate bearing, however, is an artificial regeneration work where planting and direct sowings are resorted to on a large scale.

2. The results obtained are by no means conclusive, but in view of the importance of the subject, it seems essential to review our knowledge and experience.

REVIEW OF IMPORTANT LITERATURE ON THE SUBJECT.

Effect of fire

3. Studies by F. J. Alway and P. R. McMiller (1933) in Minnesota (America) have indicated that the litter and partially humified material on the forest floor may contain 2 percent or more of nitrogen. All the nitrogen is lost, when organic matter burns (1).

4. Burning destroys organic acids and liberates bases, which further neutralize the acids in the soil, thus improving conditions for biological processes and plant growth. (1)

5. Burning changes the soil flora and makes conditions favourable for the growth of bacteria rather than fungi. A different type of process therefore occurs, probbly more of certain nutrients become available for promottion of biological action and plant growth, (1).

6. A study made with four soils taken to to depth of six inches from a stand of Douglas fir (*Pseudotsuga taxifolia*), in America, gave the following conclusions:

Nitrification in forest soils is stimulated by burning and the liberation of the basic ash matetrials.

Burning and the increased nitrification increase the soluble mineral nutrients in the soil, probably for sometime after burning.

Burning destroys not only the organic matter on top of the soil, but may destroy some of that in the immediate soil surface.

The temporary effect of burning may be helpful at least in some respects, but since the productivity of the forest soil depends upon gradual mineralization of the fallen litter, it does not appear reasonable to expect continuous and often repeated burning to improve forest fertility. (1).

7. It has been stated that burning reduces the protozoa population of the soil, thereby increasing the activity of nitrifying bacteria and this is one of the reasons for increased growth. Burning also probably provides increased potash in available form. Whatever the reasons may be every practical forester will agree generally on the benefits in weed control and accelerated growth obtained by the use of fire under Indian silvicultural operations. Burning is employed in the natural regeneration of *Shorea robusta*, for the purpose of converting an evergreen under growth into grass, thereby making use of the well-known fact that fire puts back succession and favours savannah at the expense of the forest, (3). The chief exception to the generalization that a burn is beneficial in regeneration work, is in evergreen forest types, where experiments go to indicate that a burn, if not actively harmful, in no way benefits seedling growth in these forests. (10).

8. In the case of the *Eucalyptus* observations made in a number of forest types in Australia, have shown that a strong surface fire in a Eucalypt forest will destroy practically all Eucalypt seed, except that carried by the trees at the time of the fire. Many areas are to be seen in certain Eucalypt forest regions where there is a complete absence of regeneration following a fire, and this is attributable generally to the absence of seed on the mature tree, when the fire occurred. (7).

9. Although at one time a general final burn was carried out as the last stage in regeneration operations in the *jarrah* forest (*Eucalyptus marginata*) in Australia, the use of fire in this connection, except for burning large isolated heaps of lop and top, has been discontinued for a number of years past, resulting in considerable improvement in the stocking and vigour of regrowth on treated areas. (7),

10, The only known cases of natural regeneration of *Eucalyptus* trees in India, however, have been the result of accidental fires. These fires must obviously have occurred before seedfall, or there was enough seed on the trees at the time of the fires. Profuse regeneration of *Adina cordifolia* following slash burning has also been observed in the U. P. (3), and by Mr. H. S. George, I. F. S., in the C. P.

11. In other Eucalypt forest type fire may play a useful part in securing a satisfactory stocking by natural regeneration, and may be used even to control to some extent the mixture of species in the new crop. With this latter object in view over-mature and useless trees of the less valuable species are ring-barked sometime in advance, in Australia, so that their seed falls and is destroyed by the final burn, which is designed to clean up all slash and to encourage a uniform stocking of seedlings from seed on the living trees remaining on the area, (7).

12. On the other hand, the benefit of burning after clear-felling has been questioned in the case of the plantations in Darjeeling, where coppice regrowth is desired as part of the new crop; and the utility of brushwood burning in the Punjab irrigated plantations has from time to time been debated. Slash burning in the wattle plantations of Natal (Africa) has as the result of Craib's research, been given up in favour of piling in rows. (3).

13. Effects of burning of slash etc., in Kashmir, were summarised as under.

(i) Fire, especially a fierce one, kills outright all living organisms in the soil. It is just possible that a symbiotic population takes complete possession of the soil before a non-symbiotic one can enter and consequently more favourable conditions are produced in the soil for succeeding vegetation.

(ii). With the reduction of protozoa, the activity of nitrifying bacteria is increased which improves the soil and the growth.

(iii) Severe fires kill all weed growth and give better prospects for tree seedlings to grow and flourish on the soil.

(iv). Soil is improved physically; even a heavy clayey soil becomes friable and makes good tilth. (9).

14. Experience in the field, in Kashmir, has shown that the severer the fire from slash burning, the better are the results of sowing of *Cedrus deodara* seed in beds devoid of ashes, while the contrary is true where beds are covered with a thick layer of ashes (9).

15, The most magnificent *Cedrus deodara* plantations in Kashmir are the result of good burning, where the soil was baked red like a brick. (9).

Most of the advance growth in the Kashmir coniferous forests is the outcome of fierce fires followed by fire conservancy. (9).

16. Other instances of the good effect of severe burning are the changes of succession in fir forests, in Kashmir, where vast areas of fir yielded place to *Pinus excelsa* after huge conflagrations (9).

Plate I shows dense natural regeneration of *Pinus excelsa* after a severe fire, in Bashahr, Punjab.

17. If the effect of slash burning was other than beneficial there would be none of the beautiful plantations and seedlings in ash beds in regeneration areas in Kashmiir. (9).

It has been proved in regeneration work in Kashmir that seedlings grown in burnt areas far surpass those raised even in nurseries, in vigour, height, growth and even in colour. (9).

18. The following figures give the average survival percentages and mean heights from 29 experiments conducted during five years, in the dry fuel forests of Madras (normal rainfall 24. 88 inches) comparing results of direc-sowings on

(A). soil worked, but not burnt,

(B). soil neither worked nor burnt,

(C). soil worked and burnt and

(D). soil not worked, but burnt.

Year of experiment	No. of species (averaged)	Survival percentage at the end of the second growing season.			
		A	B	C	D
1934.	4	8	14	29	45
1935.	6	20	7	47	25
1936.	6	18	11	42	41
1937.	6	9	11	49	53
1938.	7	26	25	76	71
	Average.	16	14	49	47

Year of experiment.	No. of species. (averaged).	Mean height in inches at the end of the second growing season.			
		A	B	C	D
1934.	4	13.7	10·1	14.8	10.4
1935.	6	14 7	9.3	19.2	17.2
1936.	6	15 3	14.7	25.3	25.8
1937.	6	8.5	6·2	22 5	18,1
1938.	7	9.5	10 0	32.9	27.2
	Average	12.3	10.1	22 9	19.7

The species used were *Acacia planifrons*, *Acacia arabica*, *Acacia leucophloea*, *Albizzia amara*, *Cassia auriculata*, *Dolichandrone crispa*, *Tamarindus indica*, *Wrightia tinctoria* and *Zizyphus jujuba*.

Combining all the above data we get the following results :

Treatment.	Survival per cent.	Mean height.
Burning.	48	21.3″
No búrning.	15	11.2″
Worked pits**	33	17.6″
No soil working before sowing*	31	14.9″

**The soil was worked 9″ x 9″ x 6″ at each patch before sowing,

*Only enough soil working to sow the seeds was done.

The investigation has thus given us the definite conclusions that burning before sowing is essential and that soil working before sowing is decidedly beneficial. (11).

19. An article by Frank Heyward in the Journal of Forestry for May 1938 records the results of 44 experimental fires. Findings indicate that the heat from the majority of forest fires in the long leaf pine region is insufficient to impoverish the soil, and that the slight heat which enters the soil during these fires may even favour plant nutrition. (8)

20. Experiments conducted near Leningrad showed that there is a close dependence between the forest cover and the nitrification capacity of the soil. Fire always stimulates nitrification, inducing it where it was absent previously, and considerably intensifying it where it was already present, moderate fire-clearing being better than a strong one. In some cases nitrification began almost immediately after a moderate fire clearing. In reported experiments effect of fire on the soil lasted for 5 years. In all cases the maximum nitrification occurred in the fall. Mechanical mixing of the mineral soil with the upper layer favours nitrification. Soil nitrification seems to favour the growth of grasses and broad-leaved trees more than that of conifers. (22).

21. It is possible that the effect of fire is entirely different in the tropics to what is the case in temperate climates and that any results obtained in Europe will entirely be inapplicable to India. (3).

22. Unburnt areas studied in the long leaf pine in America were characterized by a layer of pine needle litter from 2 to 3 inches deep. Except in openings in the stands of pine, only a scanty ground cover was present. On the frequently burnt areas only a small quantity of litter was present, but a ground cover, consisting of wiregrass and a wide variety of broad-leaved herbaceous plants, including numerous members of the Leguminosae was typical. Differences in the ground cover are believed to be due to burning. (12).

EFFECT OF ASH.

There are certain compensating effects which follow burning. Ash is liberated and becomes an immediate source of available nutrients. (1).

24. Laboratory experiments carried out in Germany have shown that of the seven species, pine, spruce, fir, larch, black pine, beech and birch, examined there was almost none that was in any way favoured by fresh ashes of the type resulting from forest fire either in germination or early plant development. On the contrary the ashes were always quite harmful, generally reducing the germination figure.

25. This appears to be quite contrary to Indian experience. Sowing of *Cedrus deodara* in burnt heaps of slash results in greatly increased development; the same result is obtained with the standard *rab* system of regeneration in Bombay and Madras. In Burma a good burn is considered essential for a successful *taungya* plantation and every *jhum* cutter in Assam will agree with this proposition (3).

26. It may be noted, however, that the extreme comparison of growth on ash in the laboratory experiment, is made with growth on specially selected mould, which is a more favourable seed bed than the average forest floor. It is interesting to find that even the sand-loving pine does better on mould than on sand. Germination on ash was, for five of the seven species in the experiment, better than that on sand and it is in the plant percent that the ash failed. Moreover, the average weight per plant was greater on ash than on sand for four of the species and greater even than the weight on mould for three species. Under the usual conditions of natural regeneration, size and vigour of the plants are more likely to be of value than plant percent. The experiment is therefore not so wholly against the ashes as appears at first sight. (6).

27. The poorest germination and growth of hollock (*Terminalia myriocarpa*), in Assam plantations, occurred where the ashes had been the thickest i.e., in those lines where the fire had burnt the fiercest and the longest. A comparison of the growth for one, two or more years afterwards in lines where it was known that the fire effects had not been equal, showed the best results in places where the burn was either light or practically negligible. (5).

28. Burning the vegetation returns to the soil all the mineral elements taken out by the plants during life. The relatively small volume of ash can, as a rule, easily become incorporated with the surface layers of the soil and, provided that there is no erosion, leaching by subsequent rains will wash the soluble contents of the ash into the soil. This has been demonstrated in Burma by J. Charlton (Note on the effects of *Taungya* on Burma forest soils. Agriculture and Livestock in India, Vol. VI. part 1, January 1936), who showed that the burning for *Taungya* in forest in the Shan States, consisting mainly of oaks, chestnut and *Terminalia tomentosa*, resulted in a reduction of the lime requirement of the soil by half. In Pyinmana no differences were detected except in the case of potash which increased significantly in the top 6 inches of the soil and insignificantly in the subsoil. In Akyab, *taungya* resulted in no significant changes, which Charlton considered to be due to the lack of bases in the bamboo *Melocanna bambusoides*, which constituted the vegetation, as compared to the tree growth in the Shan States. Possibly also under the very high rainfall of Akyab, leaching and run-off, which would be accentuated by the entire removal of the vegetative cover, were so great as to remove all the newly added soluble mineral materials. (6).

29. The better growth of young *Eucalyptus* which develop on and around so-called ash beds is a striking feature of the natural regeneration to be seen in most *Eucalyptus* forests, Where the accumulation of ash is very great, owing to the burning of a large log or a big heap of debris, the seedlings tend to be distributed around the edge of the ash. Field observations in Australia indicate that seedlings on or around ash beds derive benefit not only from the fertilising value of the ash, but also from the absence of grass and scrub competition in consequence of the fact that ground flora species take many years to become established on ash beds. On the other hand, attempts to stimulate the growth of young *Eucalyptus* and exotic conifers, both in the field and in the nursery, by the application of a dressing of ash have not given positive results in any known instance. (7).

30. Generally speaking, exotic pines planted after the burning of large accumulations of slash on sites on which inferior stands of *Eucalyptus* have been clear-felled to make way for the establishment of pine plantations, tend to show somewhat better growth where a severe burn has resulted in comparatively heavy deposits of ash. One exception occurs in certain parts of the south-west of western Australia, where *Pinus radiata* planted immediately following a heavy burn of *Eucalyptus* slash developed within 2 or 3 years a disorder known as "Rosetting", although the same species planted on the same soil types on adjacent areas which have been cleared for some years and cultivated or laid down under clover pasture grew quite normally. The use of zinc sprays restored the small "rosetted" pines to a healthy condition, but no work was carried out to show why young pines planted after heavy slash fires in the localities referred to should suffer from a deficiency which could be adjusted by the application of zinc salts. (7).

31. Experience in Kashmir in the field showed better results in *Cedrus deodara* seed sowings in beds devoid of ashes, the contrary being the case where the beds were covered with a thick layer of ashes. (9).

32. Sowings of *Cedrus deodara*, in Kashmir, in ash beds have failed more than once, where ashes were left accumulaled and seeds were sown over them. Just as seeds do not germinate on a heap of manure so they do not germinate on a heap of ashes, for want of mineral constituents. (9).

33. More than once was it observed in Kashmir that ash beds were full of excellent growth of *Cedrus deodara* seedlings where ashes had been completely removed from them and red soil exposed before sowings (9).

34. It has further been observed in nature that where severe fires have occurred in the Kashmir forests, no regeneration of any tree species takes place in the first two years due to the accumulation of ashes, but as soon as the ashes are removed by wind or rain, then regeneration of *cedrus deodara* or *Pinus excelsa* begins to take possession of the ground. (9).

35. Contrary to Australian experience, dressings of ash, in Kashmir, are, however, beneficial in *Cedrus deodara* plantations and nurseries. (9).

36. In teak plantation work it is common knowledge that where the burn has been exceptionally heavy and the soil has been baked red like a brick, neither teak nor weeds nor anything else except certain mosses will grow, but in such cases as have been recorded the ashes were not removed. Failure on these severely burnt patches may be due to the excess of ash and not to the baked condition of the soil (10).

37. The good effects of a burn have in the past, generally, been attributed to the manurial value of the ash. Coster in his

experiments in burning areas for planting teak, showed 62 percent better height growth in the first year. (10).

38. It is probable that these conditions differ for different species, e.g., *Adina cordifolia* and *Mitragyna parvifolia* both germinate readily in beds of ash whereas other species (e. g. *Terminalia myriocarpa)* showed a lesser tolerance to it. They will also differ for different soil conditions. (10).

39. Soils from burnt areas in the long leaf pine region in America showed pH values ranging from 0.15 to 0.48 units higher than those of unburnt areas, whereas replaceable calcium totalled as much as 101 percent more on burnt soils than on the corresponding unburnt soils. Changes in acidity and in replaceable calcium can be attributed to the addition of ash following fire. (12).

BIOLOGY OF UNBURNT AREAS.

40. Decomposition of leaf litter or any high carbon material results usually in slow production of available nitrate. Fungi which are especially active in the upper layers produce acids and thus discourage nitrate forming organisms. Nitrifying organisms are most active in neutral or alkaline soils These same fungi need nitrogen for their own cell protoplasm during growth. Any nitrate that is produced, therefore, is likely to be consumed by organisms. (1).

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THE GENUS BUXUS IN PLEISTOCENE OF KASHMIR.

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INTRODUCTION.

In the year 1911, Mr. I H. Burkill, then the Economic Reporter to the Govt. of India, identified leaves of *Buxus sempervirens* Linn. from a collection of fossil plants made by Middlemiss at Liddarmarg (alt. 10, 600 ft.; lat. 30° 4 '; long. 74° 39') in the Pir Panjal Range, Kashmir (Middlemiss, 1911, p. 122).

These are now found to belong to two distinct species (Puri, 1940, 1941) *B. Wallichiana* Baillon; and *B. papillosa* C. K. Schn. both of which do not grow in the Kashmir Valley today. The present paper is devoted to the description of these leaves which are for the first time figured and described under their correct name.

During the preparation of this paper I have freely received encouraging help from Professor B. Sahni, F, R. S. to whom I am deeply indebted. Modern leaves reproduced in photos 4, 5, 8, 9 were kindly sent me at my request by Dr. R. R, Stewart from authentic sheets in his Herbarium, for which I wish to express my sincere gratitude to him. To the Director, Geological Survey of India I am thankful for the loan of Middlemis's collection and also for supplying me at my request photographs of the fossils.

DESCRIPTION.

FAMILY BUXACEAE.

The fossil leaves belonging to this family may be linear or linear-oblong in outline. The margins are always entire. The leaf lamina usually tapers down into a narrowed base, which may in some cases be wedge-shaped. Apex is always acute.

In addition to being different in shape and size the leaves possess a distinct venation which is characteristic in the two species. The venation is usually indistinct in modern leaves which have to be partially macerated to bring out the net-work of veins for comparison with the fossils. The photographs reproduced in figs. 4, 5, 8, 9 were made from partially macerated leaves.

KEY TO THE SPECIES.

1. Leaf, oblong, secondaries many, bifurcating away from the midrib to form a wide mesh-work—*B. Wallichiana* (1)—

2. Leaf linear, secondaries more than in the first species arising very close; bifurcate and anastomose very irregularly to form a close meshwork......*B. papillosa* (2) —

(1) BUXUS WALLICHIANA BAILLON.

(Photos 1-5).

The natural size photographs 1-2 illustrate two fossil leaves one of which is about half of the leaf representing the basal portion only. The other specimen is a complete leaf, which is oblong in outline with a narrowed base and a rounded apex. The margins are entire The incomplete leaf (photo 2) seems to have been of a larger size and in this respect it compares with one of the modern leaves reproduced in photo 4.

The venation is pinnate-reticulate; it consists of a midrib, which is somewhat prominent, and a large number of distinct laterals, which shoot out from the midrib at acute angles. The laterals bifurcate and anastomose irregularly in the lamina to form a characteristic net-work of large meshes. Some of these break up into a network of smaller meshes, which constitutes a finer reticulation, seen clearly in photo 3, in which the complete leaf is enlarged to five diameters.

Our fossil leaves are identical with modern leaves of *Buxus Wallichiana* Baillon. (photo-4, 5.), a tropical shrub of the Himalayas which is unrepresented in the modern flora of the Kashmir Valley.

Number of specimens: Two
Occurrence: Liddarmarg at 10 600 ft., in the Pir Panjal Range, Kashmir.
Collections: C S Middlemiss, 1910.
Registered Nos. of figured
Specimens: Photos. I, 3 G.S. I. No. K. 14/948 a8".
photo. 2 – G. S. I. No. K. 14/950

(2) BUXUS PAPILLOSA C. K. Schn.

(photos. 6 9)

Photo 6 illustrates in a natural size a fossil leaf which is linear in outline and measures 1.3 inches long by .3 inch in the broadest part. The leaf lamina, which is broadest near the

middle gets narrowed on both sides to form an acute apex and a wedge shaped base. The margins are entire.

The venation is pinnate-reticulate with very close secondaries. It consists of a fairly thick midrib, which gives off on its either side a large number of weak secondaries in a mixed (both alternate and opposite) manner. The secondaries arise very close to one another and soon start variously branching and anastomosing to form a network, which is very characteristic. The secondaries and their branches are not only much finer than the midrib but they arise very close to form a compact network. The network of the tertiary reticulation is hardly distinguishable from the main meshwork formed by the secondaries and their branches. This is clearly seen in photo 7 in which the leaf is enlarged to five diameters.

The fossil leaf on account of its shape, size, margins and venation favourably compares with modern leaves of *Buxus papillosa* C. K. Schn., two of which are reproduced in photos 8, 9, for a comparison with the fossil.

Number of specimens: Two

Occurrence: Liddarmarg at 10, 600ft., in the Pir Panjal Range, Kashmir.

Collection: C. S. Middlemiss, 1910.

Registered No. of figured Specimen: K 14/951 (ii)

MODERN DISTRIBUTION OF BUXUS.

The genus *Buxus* belongs to the family *Buxaceae* which includes 6 genera and 60 species of modern plants; of these nearly 40 species are assigned to *Buxus*. They are chiefly temperate and tropical in their global distribuiton

Of the two sections of the genus, one (*Eubuxus*) occurs only in Europe, Asia and Africa, whereas the other section, *Tricera*, is confined to the West Indies.

Buxus sempervirens, the chief European species has its home in Central and Southern Europe and North Africa; however, it extends eastwards through Asiatic regions to temperate Himalayas and thence into China and Japan.

The Indian box differs from *Buxus sempervirens* and comprises of two distinct species (*B. Wallichiana* and *B. papillosa*) both of which have been discovered from the Karewas.

1. *Buxus Wallichiana* Baillon., a small evergreen tree, occurs in the Western Himalayas at altitudes of 4,000 to 9,000 ft. extending eastwards to Nepal and also grows in Bhutan at the same elevations. It is locally abundant in Bashahr at elevations of 6,000 to 8000 ft.; also Kulu at 7,500 ft., occuring gregariously at a elevation of about 6,500 ft. in Chamba. It occu fairly commonly in the United Provinces, e.g in Jaunsar it grows at 7,000 ft., in Tehri Garh wal at 8,000 ft., and in the hills of Kumaon an Garhwal it occupies an altitudinal zone betwee 7,000 and 9,000 ft.

It is a shade loving tree, which usuall grows under a thick canopy of Oaks, maples *Alnus*, *Taxus*, *Ilex*, *Picea* and other large trees In shady ravines and moist sheltered places i flourishes, often ascending to high altitudes; bu hot aspects of exposed rocks and snowy peak are unsuitable habitats for its growth where i is seldom found. These facts would probabl explain to some extent its localised occurrence The nature of the soil is also one of the factor which immensely influences its growth. In Bashahr, where it is locally abundant, it flourishes on shale and gneiss, whereas it grows o mica schist in Chamba, and in the Jumna Valley it is found growing both on gneiss and mica schist.

It does not occur anywhere in the Kashmi Valley, the northern slopes of the Pir Panja Range, or the southern slopes of the Main Himalayas, where it is supposed to have existed in Pleistocene times; however, it is recorded from Udhampur in Kashmir.

2. *Buxus papillosa* Schn. Unlike the first species it grows on hot and dry slopes of the outer Himalayas from Jhelum westwards at altitudes of 2,000 to 4000 ft. It extends further west into the trans-indus territory and occurs in the Garamthum forests in Hazara. Between Thal and Badishkhel in Afghanistan it has been found at an altitude of 4,0 0 ft., and was collected from the Peshawar Valley. In the Salt Range and dry hills around Kalachitta and Margalla in the Rawalpindi District it is fairly common on sunburnt soil, and occurs usually on dry limestone but in the Salt Range it grows on sandstone. In plains, it is mostly cultivated, e.g., in Lahore and Amritsar it does well as an ornamental shrub in gardens.

Like *B. Wallichiana* this species also does not occur anywhere in the Kashmir Valley, the northern slopes of the Pir Panjal or the southern slopes of the Main Himalayas.

A comparison of the past and present distribution on these two species in Kashmir lends further support to the conclusions that the Kashmir Valley during the Pleistocene had experienced a tropical climate (Puri, 1943, 1944, 1945, 1946, 1947, 1948) essentially dissimilar to

what prevails near the Manasbal Lake at the present time.

SUMMARY

1. The fossil leaves referred by Middlemiss and Burkill to *Buxus sempervirens* Linn from Liddarmarg, Kashmir, are figured for the first time and described under two species *B. Wallichiana* and *B. papillosa*.

2. A comparison of the past and present distribution of the species reveals that while they were found on the northern slopes of the Pir Panjal and in the valley during the early Pleistocene they are no longer found in these regions at the present time. All their past associates have also disappeared from this part of the Himalayas. They are, nevertheless represented in the Sub-Himalayan region, and rain forests of the North Western Himalayas today.

3. Some remarks have been offered on the changes of climate in this region and it has been pointed out that the tropical climate of the valley has altogether changed since the Pleistocene and at the present time the Liddarmarg locality experiences a temperate climate.

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EXPLANATION OF PLATES.

Plate I

Buxus Wallichiana Baillon.

Fig 1. Fossil leaf. G.S.I. No. K 14/948 a8 Nat. size.

Fig. 2. Incomplete fossil leaf, G.S.I. No. K 14/950 (i) Natural Size.

Fig. 3. Fossil leaf (fig. 1) enlarged to show venation. X ca. 5.

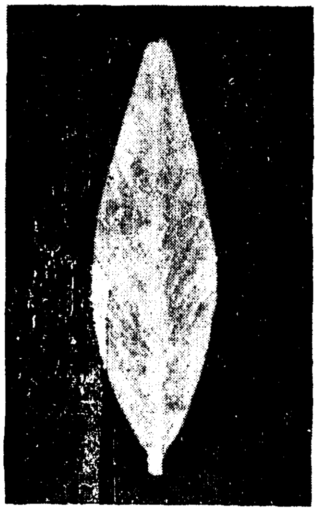
Fig. 4. Modern leaf, partially macerated in water to show venation. Nat. size.

Fig. 5. Modern leaf enlarged to show venation X ca. 4.

Plate II

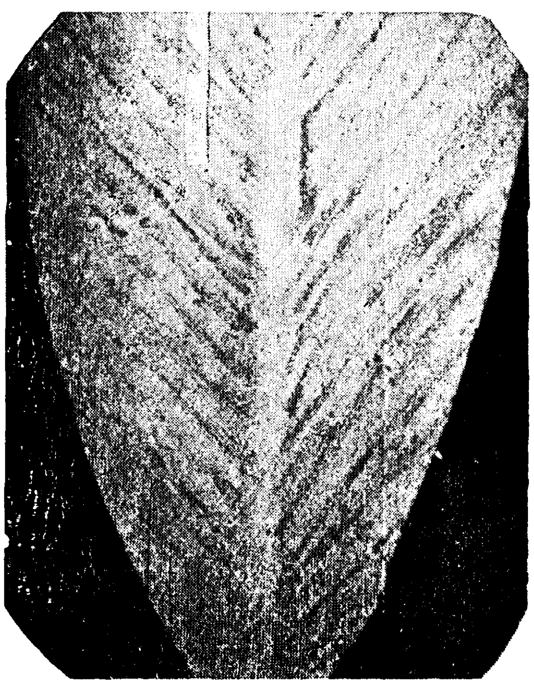
Buxus papillosa C.K. Schn.

Fig. 6. Fossil leaf. G. S. I. No. K 14/951. Nat size.



4

5 Xca. 5



G S P. & G S I. Photos

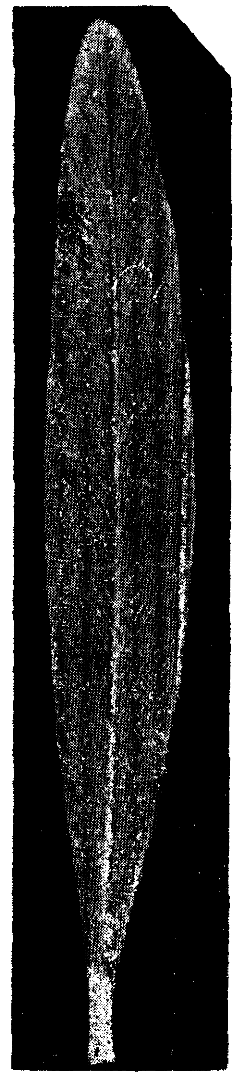
2. Xca 5

1

3

6

8



9 x ca. 5

7 x ca. 5

G. S. P. & G. S. I. Photos

Fig. 7. Fossil leaf enlarged to show venation X *ca.* 5.

Fig. 8. Modern leaf, partially rotted in water. Nat. size.

Fig. 9. Modern leaf enlarged to show venation. K ca. 5.

WHICH WAY DARWINISM

By Shri Sher Singh

Evolution implies advance and progress. But against what? .....against something stable. So there must be both mutability and immutability......and out of these, mind is mutable and evolving, and the body is somewhat fixed or stable, as it should be. The latter also changes with race-crises or transitions.

It is not intellect alone that emerges, it is Beauty and more: Consciousness which also comes in......like Gold sparkling out of heaps of sand, mica-dust and rock detritus. The 'gold' will correspond, in this case, to Beauty, 'sand' is body-matter, 'mica-dust' being merely vital energy. It has been recognised of late that at different levels (or shall we call them crises?) a somewhat new quality appears on the horizon: as I-Consciousness in man, which is quite apart from somewhat dim consciousness that is associated with nervous mechanism which pervades all creation. This consciousness is, therefore, in a class by itself, and is head and shoulders above that general consciousness which is in lower creation. Instinct found in ants and bees, and in other animals is on a much lower scale; indeed, it is like a dwarf-foot-hill as compared with the high Himalayas of Reason. With regard to instincts Darwin himself wrote: "*The instincts appear sufficient to overthrow my whole theory*" for he could not find out any stage when the honey-bees, for instance, built their honey-combs any the less symmetrical: there were never 'variations' one way or the other, and it was obvious, that some organic force made them already 'perfect' i.e. such as they should be without requiring improvements whatsoever, as they have never done in the past. If this is so for 'instincts', how much more should be the great gulf of separation when we reach the stage of human consciousness which is *sui generis*..... quite apart from the remaining animal kingdom. Considering these extraordinary changes which have no normal variation connections with the predecessors, but stand up quite apart infinitely more than what even the ordinary mutations will postulate......the conception of evolution has been expanded so as to include these Higher Changes ....this is called EMERGENT EVOLUTION. This is, therefore, *one* direction in which Darwinian theory has been modified of late, but this is not all.

There is another change which is still more subtle inasmuch as it covers the whole field of 'small' changes also. In the past, attention was concentrated on special changes or 'adaptations' which brought an organism into line with the environment. Now, it has been realised that animals have, in their protoplasmic-complex, higher adaptability so that they can live in different habitats *in spite* of adverse surroundings; and this adaptability enables the plants to have, somewhat similar control over nature as an European, for instance, has on his environments for he manages to live in hot countries just as much as in cold. Many instances of this kind have been worked and tabulated; for instance, in the case of insects that live in extra-hot deserts where they can do so by deep burrowings, where in the external temperature does not disturb them, and when they can come out in cold night......and, at the same time, the insects can live in other places with some equal elasticity. This has been called the THEORY OF ORGNIZATION which is described as under by Robson and Richards:—

"Animals are not only adapted to deal with special stresses and crises of their environment, but they are also able to regulate themselves to a diversity of environmental stresses and to avoid the evolutionary 'blind alley' of speciaIization. As Bateson has said, we animals, live not only by virtue of, but also *in spite* of what we are .....There are two processes at work at any rate in the higher animals: the selection of the environment by the animal 'as well as' the natural selection of the animal by the environment ".........Darwin emphasised the latter, but Organization now emphasises the former. The Darwinian theory was somewhat negative and deductive, this is more positive and has greater comprehensiveness. This explains difficult cases of co-ordination and particularly of control of temperature by living creatures: as the honey-bees do, for instance, by 'fanning' their beehives. On the other hand, the ants and even the bees have higher temperatures in their nests at breeding time particularly. Thus in ants, Wheeler (1913) records that the temperature may be higher by 10 degrees centigrade as compared with the outside air. This points to higher 'organisation' or

mode of 'life' which overcomes environment rather than succumbs to the same. If this is true, as it appears to be the case, the 'variation' is but one rule by which Life overcomes resistance i.e. by 'proselytization' i.e. by becoming blindly sheep sh to the chain of enviror ments. More often, living beings overcome the iron causation by their ebullient activity and are adaptable to more 'spheres of influence' than one. This is just as it should be if Life has some independence and freedom of its own: freedom to adopt more than one of the many alternatives, and even to migrate from unfavourable circumstances to places where amenities of life are more abundant. Instances of this mass-migration occur as much in insects as in man......so, after all, there is no hide-bound course as the old theory postulated .... thus more 'elasticity' hss come in our conception of biology of late.

Moreover, it is realised that it is not merely the 'unfit' that go to the wall; not unoften, even the so called fit ones are decimated .....this is what has occurred in the past say by goat destruction of forests and likewise by fire or other such uncontrolled forces. In these cases, the goat and other harmful animals do damage indiscriminately: to good and bad species alike. Erosion is another phenomenon which acts on a colossal scale, causes such as these over-dwarf the stereotyped Darwinian considerations of old.

Last but not least, we cannot ignore the tremendous importance of 'experience' both in the collective memory of races, as also that of individuals. The following example culled at random from one big list of such experiences is quoted from Reinhard's experiments (1929) on a wasp in which case a "female wasp was confined in the centre of three concentric glass funnels standing on sand. On her first attempt she burrowed under the edge of the inner one and ran up between it and the second; on trials 2 to 15 she burrowed under all three funnels; on trial 16 she behaved as on the first occasion; while on trials 17 to 22 she ran straight up the neck of the inner funnel. After each trial she was captured and placed in the centre again, till, on the 22nd escape, she eluded capture. (quoted on page 354 of RS's book *ibid)*. If even the little things of earth profit by their experience, why not higher animals? The experiments of Pavlov in Russia on rats and apes, and on conditioned reflexes, also tell us relevant tale. Macdougall has presented evidence to show that rats trained over 23 generations may be definitely modified: the animals had to escape a basin full of water. They could attempt to escape either at a lighted platform (in which case they received an electric shock) or at unlighted one (without a shock). There was evidence that the number of mistakes made by the rats before they chose the exit where they did not receive the shock was gradually reduced with each generarion. It appears, therefore, that a *prima facie* case has been made out for inheritance of acquired characters, although the same cannot be said for each and every character. It must be an effect of deep penetration which can effect the germ cells. This holds out a ray of hope for all those who believe that we have our evolution 'in our own hands', in other words, we can exercise intelligent selection and thus, guide the course of destiny from generation to generation, towards betterment.

All this shows that Darwinism has to be superseded by a super-Darwinian philosophy which, interalia, believes more in subtelety of Life than in hide-bound causation and adaptations; the rigid chain of determinxism is breaking as much in biology as in atomic world of physics; and we are seeing the dawn of New Day that of Divine Superintendence emerging in higher and yet higher planes of Reality. Darwin had his eye chiefly on vital re-actions and physico-chemical considerations; now, we have our eye on the Inner World of Life, Mystery, and interplay of Forces which have their roots deep in the Logos, Wisdom-Divine of which Beauty and consciousness are *two aspects supreme*

III

THE ORIGIN OF MAN & MODERN DISCOVERIES.

The Ape and Man: some differences.

This account will not be complete were a brief mention not made of the modern discoveries on the origin of man. That there is some relationship between man and monkeys is abvious enough for the latter also stand erect at times and suckle their infants. The ape has been considered to be a near 'ancestor' of man with some 'missing links' which anthropologists have long since been trying to discover. Since Darwin enunciated the doctrine of evolution much water has passed under the bridge and, for one thing, we know as certain that no ordinary variations can account for origin of man .....it must have been, some deep change: a tomutation and a very 'extraordinary mutation' too Between ape and man there are some fundamental differences and of these the following may be mentioned:—

1. In human races, the average capacity of brain is 1400 cu. cms. and ranges

actually from 920 to 2000 cu. cms. In gorillas the brain rises up to 610 cu. cms. and rarely a little more.

2. This brain increase is explained by longer period of gestation as it takes 280 days in man, as compared with 220 days or less for apes. This longer period means much delay in hardening of the skull, and therefore, a greater period of growth.

3. The sutures of the human skull do not close till the 39th year, while in apes and other mammals the skull is made a hard fixture in a year on two after birth thus, there is 30% after-growth in ape, 200% in man.

4. Then there are bony eye-ridges in apes which are absent in man.

5. Lastly, the lower jaw is massive in apes, and there is no well developed chin, while in man the jaw is smaller and with well-modulated chin. The absence of '*tail*' is also worth mention in man.

Apart from these, mention must be made of the intellectual equipment of man, and, above all, his appreciation—which two features bring him on a much higher level than what the body-mould alone will indicate. And to that add the copious faculty of intelligent-speech (on which rests all literature, so valuable a part of man) and also other achievements which are not only connected with intellect, but with the discovery of 'Soul' which feature is entirely original to man. So remarkable and so deep-seated are these differences that there have been some scientists, besides theologians, who have held that man is in a class by himself, and that lineally he has over-stepped all genetic bounds and has come out as a new creation. On the other hand, the whole burden of Darwinian philosophy lies in the fact that there are but slow and linked changes from one end to the other and that there are no unbridgeable 'gaps' (as leaders of super-Darwin School will suggest).

From the time of Darwin there have been two schools of scientists: those that stuck to Darwin and those that have differed from him. From amongst the latter Sir Oliver Lodge may be mentioned, and his place is now taken by Prof. Fleming F.R.S. who has started a separate society of which one object is to emphasise the unique 'creation' of man and his unbridgeable differences with the ape-world.

The Controversy.

The controversy has hinged around the question of emergence of new characters. In *brief, it may be stated that on the old theory,* we can have but permutations and combinations of the genes, but never a startling product much different from the primeval old stock. If we take a fountain, for instance, or rather a series of fountains, graduallv lowering cascades, then the rise of water in one and all is regulated by the headwater behind, it can *never* rise more than the level of the tank in the background supplying all fountains. This is true according to the laws of hydrostatics, and who can deny this ? but it is just here where the Darwinists differ: they declare that 'more can be got from less !' in other words water in the founts can go much higher than that in the supplying tank, against the laws of water level !......it is just this which is the trend of evolution: more and more from less and less ! Those who begin from amoeba, the living unit and work up are confronted with this difficulty, but on the other hand Sir A. Keith on whom the mantle of Darwin has fallen, defends this on the ground: "We find this .....the lower produce the higher ......happening around us every day; our evolution ever tends to move from the simple to the complex, from the low to the high". But here the crux lies: The seeming upwardness cannot come from the basic amoeba (if that is the origin); it comes, as the other school postulates *from the Mindinfinite of which the protoplasm* is but significant-spark and emblem. We can work down from infinity and get down to any numeral, from 1,2, 3......9......on to 10000000 ...or......999999999 etc. but mere-one cannot, by itself, give as much as two, much less the hydra-headed Variety that is associated with this seemingly-simple Unity (i). Flemming rightly, in my opinion, emphasises: "It is erroneous because it (evolution) attributes the production of phenomena which appear to our intellect and emotion to an agency which is impersonal, unself conscious and has no intellect or emotion itself and, therefore, cannot produce them......It is merely a PERSONIFICATION OF THE CONCEPT OF GRADUAL AND CONTINUOUS CHANGE". Continuing, he says, that its basis lies back in the Thought of the Supreme Thinker, i.e. God. This is not to deny the existence of gradation in all creation: such is planned-creation, no doubt. But all this comes from Above ; and does not go up, from below *vertically; as the momentum can never be more* than the headwaters behind, which will be the pigmy-amoeba in this case.

Even on general considerations, one cannot expect 'more from less' but as we have been

'drugged' to think like this by Darwinian philosophy, so the following from Prof. Bateson, who is a foremost living aetiologist, is worthy of special condideration; he asks us to consider "Whether the course of Evolution can at all reasonably be represented as an unpacking of an original complex (proptoplasm)......We may as well see whether we are limited to the old view that evolutionary progress is from the simple to the complex, and whether after all it is conceivable THAT THE PROCESS WAS THE OTHER WAY ABOUT." He stresses the latter view and in support thereof states that our cultivated Peas "have been derived from the one wild bicolour by a process of successive removals"..... not of successive additions, as we are accustomed to consider. The change in thought is not new, it is as old as the Theory Divine, which proceeds up from the Simplicity-all-inclusive, and then explains things by successive removals. In radium, for instance, we have the process of paring i.e. of splitting of the complex into still simpler units, each step marked with radio-activity and emission of Protoplasm is, after all, not so simpe as we think, and the 'potential-Immortality' of the amœba, will itself demonstrate that we attain our complexity by the 'death' of that inner elasticity which is at its highest in the immortal-amoeba. The current of opinion has been turning round, of late, and evolution is now considered also as a process of 'devolution' from the highly-complex to very simple.

Probably truth lies in reconciling both the views. but the reconciliation can come only by recognising the mystery of life with which is connected the problem of protoplasm and its complexity, To say that life originated *de novo* i.e. of itself from chemical elements is again to deny its essential mystery. Opinion is veering round to the other side that Life IS ORIGINAL, and that all matter is derived from it, and not *vice versa*, much as we know now, that Energy is the first basic stuff, and that atoms and molecules are different aggregations thereof. It is for this reason that classical wave-theory is now being reconciled with energy-quanta, which are parcels of energy. Likewise, Darwin's conception of old has become much too old for modern bio-genetics. We recognise the mystery of protoplasm and meet it half-way by bombardment with neutrons and other high-speed particles ..i e. we meet it by coming to its own plane, which is that of Energy. This is just as it should be, and this indicates the change that has come over since Darwin's time. It is the keynote to understanding of what follows.

The Origin of Man.

The origin of man must have no doubt come from the living-Spark, that of Life, which is associated with sex cells. One thing is certain: before animals can come in, there must be food for them which means that animal kingdom must come after vegetable kingdom, and, similarly, vegetable kingdom has of necessity to come after mineral kingdom, as roots must have some soil to live on. Similarly man, the crown of creation, must come after all lower units of creation, including ape-world. This is just as may be expected. But the whole problem lies around the query: "Is man a lineal descendant of the apes"? All must depend on how we interpret the word 'descent': a duck's egg is hatched by a hen, but the duck does not become thereby identified with the hen—it is different, as ever it was. The cuckoo (that has been studied for the last 100 years) is known to select more than one fosterer for hatching its eggs; now merely keeping the eggs under some other bird does not give it the stamp mark of the mother. In much the same way, I conceive, that the first egg-cell of man was 'created' independently (how? by Logos, which is a matter for separate discussion), and the fact that it came out of the ape line by process of 'mutation' (call it any fundamental change) does not prove that man came from the ape-ancestors; the spark did the work of a fosterer and no more, but the seed Nucleus was already planned and it was as different as chalk from cheese, In this way, more than one seed-strains have come from the same primal-complex which is the Egg-cell of the highest mammalia, the apes and their cousins. Darwin may be credited for inter-linking man with this 'ape-world' but the latter is only a foster father and not a real 'ancestor' of man. In much the same way, all novel departures of 'species' must be attributed back as due to the Floating-Logoi i.e. to Ideations-Supreme. The bearing of this will be evident from modern discoveries, cited below.

Separato Races or common origin?

Of late it was thought that Man must have originated at one place, and on one date, from some ape-ancestor by a process of 'mutation' and from this antique-man, however produced, all must have come, as different bránches come from the same stem. The Darwinians have held this conception (as much as the Garden-Eden theologists). Here I may refer to the following remarkable confession of no less a Darwinian than Sir Arthur Keith himself who writes as under in *nature*

(June 17, 1944) regarding Evolution of Man or Homosapiens:—

> Most of us who, a decade ago, were making a special study of the fossil remains of man believed that we should find, some day, the remains of a type which would serve as an ancestor for all living races, and that we should 'find this ancestral type spreading abroad in the world, exterminating the other Pleistocene types; ALL THE EVIDENCE HAS GONE AGAINST THIS SUPPOSITION...
>
> "EVEN so late as 1931, I was still in doubt as to the ancestral position of pithecanthropus. Then, with the discovery of later fossil types in Java by Dr. Oppenoorth in 1932...it seemed to me that the chain of evidence that links the Australian aborigine of today with Pithecanthropus of the early Pleistocene was complete...."

Keith, therefore, now recognises that the races which are found different in different parts of the world had, therefore, independent origin i. e. by evolution taking its initiative irrespective of what was happening in other parts of the world, and that there has been 'convergence' in character. Thus, the Mongolians were a different 'strain' from the 'Aryans' and the latter from the African Hottentots, for instance. In this way, the fossil-finds of old, of Pithecanthropus,Sinanthropus and Neanderthal, are, thus, connected with the different races now inhabiting different parts oi the globe i.e. separate orign for separate races. More: lamps of light appear to have been lit in distant places almost simultaneously and independently. Quoting *Science Progress Journal* July 1933 "These finds in England (Piltddown Man) are supported by other elsewhere such as those of Dr. Leakey in Africa and those of Sir Arthur Keith amongst the Palestinian fossils"......"we do not really know what to make of the Piltdown jaw, but the cranial capacity of the early Englishman was well up to the present-day level, and the beetling brows were absent. Clearly if these things are so, the VIEW PREVIOUSLY ADVANCED THAT PITHECANTHROPUS, SINANTHROPUS AND NEANDERTHAL MAN FORM A SERIES LEADING FROM APE TO MODERN MAN, NEED NOT BE TRUE; and the problem is presented that modern has an antiquity as any of these fossils." The writer of this article, Dr. Woolard F, R. S. also comes to the same conclusion as stated before namely that Complexity comes from chipping—away the primeval-block (Proptoplasm ?) and not by building it up. He says: "These observations reveal the genetic make-up of the phylum from which modern man has come. If the germplasm already contains the characters which, when assembled together, give the modern man his especial features, then, of course, the problem becomes one of finding out the possibility of assembling these and omitting or suppressing those which do not enter into his makeup." This is a startling confirmation of the theory from which we started that the Darwinian-beginning is very often a parody of the true facts: it is but a 'negative' of the positive process—for instead of 'additions' there are successive, artful 'chippings' of the parent-block. the Protoplasm-Complex in the germcell. It is this which is sorted out by the Mendelian-mosaic at the time of birth or scissoring.' Another change: ape or monkey-ancestry?

Some qualitative and quantitative characters which have been studied by Straus, Schultz and others (ib: *Science Progress*) show man is *not* related to ape, as thought of old, but has descended from the primate stock much earlier, and this is confirmed in many ways: "Man, for instance, has small canine teeth and chin, In all apes the canines are great teeth, but the chin is absent......The humerus of man shows very occasionally an entepi-condylar foramen, a feature which occurs only in the very basal primate stock. These are characters tucked away in the recesses of the body, of no apparent survival value, and not exposed to the rigours of natural selection. They live on because their genes have enjoyed unbroken succession." Thus, monkey becomes *never to* us than the ape, of old. As regards changes he adds rightly: "Palaeontology suggests gradations, genetics makes it possible that it might have saltatory with few and large gradations." If this is true, man does not descend from the 'ape', he is contemporaneous with a more primate, stock. Therefore the search for 'missing links' was but a misdirected effort. Man emerged somewhat suddenly whereas his cousins: the apes, still continue to dribble and grovel on the earth. This is one more reason for spiritual assimilation of all the facts, in the light of modern research.

Awareness or pre-awareness?

There is another point namely that of consciousness which has been referred before. We have somewhat extreme form of consciousness which is not only perceptual, but conceptual, which has a definite pre-vision of the future. Before we come to man, let us take this consciousness for instance, this has this peculiarity in parti-

cular Quoting on this 'the Science News' (Pelican 1946) reads: "for some reason not fully understood, plants with double the normal number of chromosomes are usually giants. *Sequoia* seeds treated with colchicine have already grown leaves and twigs thicker than normal, and there is not much doubt that when they grow to full stature they will be taller than the normal redwoods" (already gigantic in stature, as they are). So it appears from this that 48 chromosome variety (the white man) is only a duplication of the 24-chromsome variety, the dwarfman of Africa. If this is true, whiteman is subsequent not only in civilization but even in origin.

Incidentally this has also much bearing on the Aryan tribe. Rather than stating that the Aryans came from Scandinavia via Russia into India, the modern evidence is all in favour of the fact that this Civilization started from the Indo-Gangetic plain and radiated westwards, first touching Persia and then going into the West. This subject cannot be discussed here, but there is ample evidence on this point. Indeed, another theory has come into the field that civilization, in northern India, also came from the Dravidian south, which had its organic connection with the then (but now submerged) continent the Gondwana.

Prof. Childe has developed this thesis at great length viz. origin of civilization in the Orient (vide Science Progress, 1938-39: P 562) and may not be here referred to any further. Even the discovery of the Piltdown Man in Sussex (which would take Britain as far back as other civilised countries in the East) is now denied by some archaeologists although others suggest re-casting of the same facts. The fact remains that the origin of man—rather of independent origins in different valleys—has to be sought in places; not in cold and inhospitable hills.

Evolution and eutropy.

The above leads us on naturally to the great antithesis that prevails between Evolution or so-called progress, and Eutropy which, from physical point of view, is greatest amount of disorganization, which, therefore, bespells ruin or distant decay. Physics is married somehow to the latter, and already prophesises a day when all 'heat' will be dissipated and even the sun will be no more, and thus, there will be no life nor progress. Which alternative is true? There is a great dilemma for the modern science here. But this dilemma is a creation of 'science' itself. Is there no way out? There is. I will take an illustration, to clear this, first. Suppose a ceiling fan which is just revolving does not work; a child will think that there is something wrong in the fan, but more often than not, the trouble lies further back......in the powerhouse that stopped sending current. Those who look to the sun, and sun alone, are puzzled when they see the sun in its emebers. But, I for one, believe life did not come from matter, but from life, and that the headwaters of Life are Infinite, alth ough hidden in the background. I must look back from the ceiling to the powerhouse; thus considering, there can be no real 'entropy': there is change, and change-ordered, which can be better identified with evolution than with entropy so-called. Evolution is a gospel of hope—it is this connotation of the word which has attracted the attention of the thinkers, and hence they have fallen in with the idea, without judging the merits of Darwin's hypot hesis in further detail. Entropy is, thus, a shadow of false-outlook: it is spiritual-myopia.

Evolution and Ethics.

Prof. Julian Huxley's Romanes 1943 lecture is devoted to this subject. He begins with the inadequacy of intellect as a true measure of judging progress and ends with the somewhat unexpected (unexpected from him) conclusion in the lower kingdom. Prof. Lioyd Morgan, author of theory of emergent evolution, has expressed this factor of mind action clearly, thus "This factor is not merely awarenss...it is pre awareness It is always awareness which by however little, forestalls the coming event, always in a measure anticipatory—It is always this at its very lowest level; and at its highest level it is this developed into definite and distinct prevision of ends, thus rising to the fully teleological status—"This argument appears to me to fit in best with the hypothesis that consciousness is basal in life, and that it is covered, or occluded, more as we go downward in the scale, Man is, what he is, because of this perception which is immediate to him namely that he is primarily spirit, and is body afterwards. It is this which has concentrated his attention on 'immortality' which conception appears to have dawned to him not today, but back even in the glimmer of civilization i.e. in the dim primeval-past. Surely this could not have happened if consciousness were an after-acquisition, to be had by slow encroachments or acquisitions; he has had it almost contemporaneous with his origin i.e. branching off from the primate stock.

First Origin of man: where?

Following the clue that man could arise only where amenities of life are most suitable i.e. fruits and nuts available in abundance, we

have no doubt that this must be somewhere near the tropical belt which is known for its evergreen trees and fruits all the year round. Somewhat similar facilities may be expected in the inter-riverain valleys such as we find in the Indo gangetic plain, the Mesopotamia, and in China where the greatest rivers in Asia are found; and likewise in the Congo-Valley in Africa. Hence, it is just in the fitness of things that some of the most important fossil finds bave been from Africa, China, Java and some parts of India. It is in these valleys that the rigors of climate must have been least and where man could have little resistance from the forces of Nature. All advance must obviously to begin with, be along the line of least resistance such as are these valleys full of food then as now. If this is true then the high hills and the Himalayas and for that matter, all upper-Europe which was then subject to glacial drifts (which recurred many a time in the historical past) must have received the sparks of civilization, and even of colonization by man much latter. The course of historic finds such as we have come across at Harappa and Mohenjo-Daro in the upper-India, and similar finds in Mesopotamia and, even beyond startling proves this.

The chromosome Number.

There is an important item to be considered in this respect: it is the question of the Chromosomes, and their number, for this sheds much light on the course of past events. Attention is drawn to the following paragraph from Prof. Thomson's Gifford lectures (1924) "Competent observers have stated that the cells of the male negro have 22 chromosmes and it is probable that the negress has 24, at least in some cases. Now in the white man and woman the enumeration of Iniwarter and others have usually been 47 and 48. Concluding, he asks, pertinently: "There is no harm in asking, as Dr. Gates does, WHETHER THE WHITE MAN MAY NOT HAVE ORIGINATED FROM BLACK RACE BY A" tetraploid mutation and its consequence''......it will be remembered that in diploid nuclear fission, the number of chromosomes remains the same, whereas they become half in 'haploid', so that 'tetra-ploid will have double (not four times) the original chromo-some number. This is not only a speculation, but an interesting deduction from what we see done in laboratory today. It has been found that certain chemicals have the property of 'doubling' the chromosome number........... colchicine taken from the autumn Crocus, for that this standard lies in EMOTIONAL EXPERIENCE WHICH HAS INHERENT VALUE all its own. This is returning to the doctrine of values in philosophy.........and realization of Beauty, of Truth, and Reality which are three Values par *excellence.* It is just these which Darwin felt as slipping from him the more he specialised in intellect. Unless we develop our cultural side just as much as the intellect, our civilization is bound to suffer from the same decay from which the dodo and other big mamamals suffered: in this case, fossilization from-within due to unfertilised-intellect i.e. the intellect which is like the Jumna and has no 'intuition' being better the Holy Ganges ever-a true complement of Reason. Thus, even an 'agnostic' philosopher (like Huxley) has realised this basic truth: Omnipotence of emotions in our further Development towards Reality. Fortunately, it is not only man that needs this equipment (and has it) it is shared by all creation; and the pigeon and the peacock are hence really *emotional* when they display their plumes to their best advantage. This is particularly true when the birds sing, or when the cobra dances in tune with the flute. Indeed, the emotions are the very 'salt' of life, and what would be man without them?..,,.....especially, without music?

The Higher Music.

In what direction is our evolution tending? Not so much in the direction of efficiency wooden for that is but the bass-note of all creation-it is necessary, but only as a foundation: the second direction is that of Beauty which is the next essential that caters to Reality; the third is criticial judgment or Reason on which all science is itself based .....last, but not least is the dormant faculty in man (just awakening) by which the seers and the prophets from amongst us can 'hear' the Music Higher, the music which is the soprano or the keynote of all creation and towards which all creation moves. It is the ultra-Sonic (compare with ultra-violet end of the spectrum)......which is quite as real, but which is shut up from us until we learn to rise up to high pedestal of appreciation of that Music supernal. The *superman* (for which creation is labouring) is that Form-Angelic which will be attuned to these Higher Vibrations from which all light and life spring, and which are the basic Stuff of Life. If we see Nature in all entirety, particularly in man we find that out of five senses, the sense of smell is already receding, for that was the dog-instinct in us, tied to the earth; and the eye is developing extraordinarily but the most complex and the highest of all senses is the sense of hearing.........the hearing of music-external; it is the Ear Inner which is, likewise attuned to Highest Vibrations and it is this sense (higher than our highest).........which has

to be developed next. Do we not se} that the pititary gland has already focussed much of our attention inwards; beyond this towards the pineal gland, lies this Ear-Inner, and it is *this* Radio-internal, which when heard, will give us first-hand knowledge of the Basic-Stuff of Reality. To *hear* this is to be identified with God: for, HE IS OUR HIGHER-CONSCIOUSNESS, INTRODUCED TO US BY THE SUPER-NORMAL HEARING, or the Ear-Inner!

Conclusion.

Darwin had a little 'vision' and he graded things vertically from the lowest to the highest, and he discovered or 'posited' small steps or Variations. Drawin gave great impetus to Wesyern thought. He was soon shown that Variations are but a fractional part of the Ladder of Evolution there were 'jumps' and spurts called Mutations. So far so good. But evolution is not all 'iron' alone.........here and there, we also discover streaks of 'gold' namely of Beauty. These have to be dealt with on a different theory: that of Values. Then there is appearance of Consiousness which postulates nothing less than the theory of Emergence: something new and novel at every step. That is another feature which has to be accomodated in the theory of old. Thus, Darwinism has now been superseded by Super-Darwinism slowly but surely. There is great ferment all around. And we have come back to the starting point common to all religious books: Man is not flesh and blood alone, nor again ganglions-and-brain......he is censciousness and a spirit: he is progressing from step to step, but chiefly by flights till he reaches the Empyrean of Higher Vibrations: it is then that there comes true Awakening, and, what is still more: Enlightment and Bliss. Darwin saw this 'dream' at one end......at the red-end of the spectrum: we have to travel to the other end......to the ultra-violet end reaching which we out-reach ourselves and are indentified with the Highest Being. There are two modern books which have opened our eyes somewhat: 'The Illusion of Personality by H G. Wells, where he has worked at the matter, like Buddha, and shown that the personality is really no certainty; it is a 'knot' or *skandha*, a shifting sand and no more. The second book, again from the West, is Bernard Shaw's 'Back to Methusaleh wherein he points that the Reality is impersonal, and is combination of the two sexes: is bi-sexual, in fact. What he really means is that we have to dissolve our 'poles' of separation into the all comprehensive unity. This consummation can come only on hearing the Music-Higher for that is the only solvent of all differences and revealer of Reality. I reserve the term 'evolution' for the 'smaller' issues; but associate the capital-lettered EVOLUTION with 'supper-Darwinism' which is already coming to us at full speed.

Man is heading for a New Triumph—the triumph of Evolution 'over evolution'. There is but one urge or motive behind all Evolution: it is to *know* the Infinite, and to be identified with the same. Man alone of all creatures has this potentiality and it is the aim of all evolution to realise *this* potentiality. This objective as soon as realised turns the seer into a Superman. It is this consummation to which all creation is tending and it is a goal common to one and all......universal emancipation of all mankind, no matter how long the time spent on this: for time itself is infinite, like its Maker. That is then the Supreme Goal, the Goal-democratic, our common End.

FOREST RESEARCH INSTITUTE & COLLEGES

NEW FOREST, DEHRA DUN

Celebration on the first Anniversary of Independance 15th August, 1948

FLAG SALUTATION CEREMONY

EXHORTATION BY SHRI C. R. RANGANATHAN, I.F.S., PRESIDENT

Ladies and Gentlemen,

As the head of the Forest Research Institute and Colleges, I have just had the privilege of hoisiting our national flag to celebrate the first anniversary of our Independence Day. This is and will always be a great day for us. But on the present occasion our joy is tempered by the afflictions that our country has gone through and the bereavement we have suffered in the death of Mahatama Gandhi in our first year of freedom. It has, therefore, been decided to limit our celebrations this year to this solemn ceremony of hoisting our flag.

I have often thought that the staff and students of the Forest Research Institute and Colleges constitute in an unusual degree a very

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THE DANGS

BY

J. V. KARAMCHANDANI, BSc. (For.) Edin.

Chief Forest Officer, Dangs

Very little is known of the Indian States, more so of those States which have been treated as Administered Areas under the Crown Representative. Dangs was one of such States which has now merged in Bombay Province according to the Notification by the Ministry of States

General & Political:-The territory known as the Dangs consists of a group of 14 small States extending from 2022' to 215' North and from 7328 to 7352' East with an area of about 660 square miles; the extreme length being 52 and breadth 28 miles The tract is bounded on the North by Baroda on the East by Baroda, West Khandesh and Nasik District; on the South by Nasik and Surgana State and on the West by Bansda and Baroda States and Nasik District.

The territory of each Chief is known as a Dang, Thirteen of the Chiets are *Bhils* and one is a *Konkani*. Four of the Chiefs are known as *Rajas* and eight as *Naiks* while one bears the title of *Pradhan* and one that of *Pawar*. The population according to the census of 1941 was 40, 498 of whom the principal tribes were *Bhils* (14,134) *Kunbis* (9,932) *Konkanis*(6,412) and *Warlis* (5,705). The language of the Dangs is a dialect of Marahathi, a few villages adjoining the North Western border speking a dialect of Gujrati.

The jurisdictional powers of the chiefs have for many years been exercised on their behalf by the Political Agent. The chiefs retain certain revenue rights over their own territories and certain customary rights of settling tribal disputes. The whole area was, however, treated as Adminstrative Area until the 15th August 1947 when the Paramountcy lapsed.

The country is wholly situated in the hills and is covered with thick and valuable forests It is broken by deep ravines through which the Ambika, Purna and Kapri rivers and certain streams flow in a South-Westerly direction towards Surat District. The highest elevation is 4,358 ft. Mineral sources are not beleived to be valuable. In the valleys good black soil is often found, while on the slopes and uplands it is generally reddish in colour. Rainfall is heavy averaging about 85" a year; and during the autumn the climate is unhealthy on account of malaria. From February to the break of monsoon the climate is generally unhealthy and except in some of the valleys not unpleasantly hot.

The history of relations whith Dangs begins in 1818 with the occupation of Khandesh but it was not till 1842 that the forests were leased by the Chiefs to the Government under the loose control of the collector of Khandesh who exercised the Powers of the Political Agent. In 1903 the charge of the areas was transferred as a matter of convenience to the collector of Surat as Political Agent, the Divisional Forest Officer being given the Powers of an Assistant Political Agent This arrangement continued untill the transfer of political relation with the Gujarat States from the Government of Bombay to the Government of India (Crown Representative) in 1933 when the political charge of the area was vested in the Secretary to the Agent to the Governor General, Gujarat States & Resident at Baroda who was Ex-Officio Political Agent, Raw Kantha, Surgana & the Dangs. With effect from 4th November 1944, the charge of the Dangs States Agency was transferred to the Political Agent of the newly created Gujarat State Agency with headquarters at Bulsar in Surat District about 50 miles from the Dangs.

In 1943 the Divisional Forest Officer was relieved of his responsibility on the adminstrative side and a Civil Administrative was appointed and placed in charge of all departments of adminstration except Police, Forest, Medical and Public Works which were under the direct control of the Political Agent who was subordinate to the Hon'ble the Resident at Baroda and for the States of Western India & Gujarat Since August the 15th, 1947 when Paramountcy lapsed the Civil Administration passed into the hands of the Executive Council.

The capital of the Dangs and the seat of law courts and government officials is at Ahwa a plateau about 1600 ft. above sea level in the centre of Dangs. It is joined by a metalled road to Waghai the railhead of the Gaekwar Baroda State Railway narrow gauge line from Billimora. A daily bus service run by the Administration carries the post and passengers to Ahwa. A telephone line links Waghai and Ahwa. There are two post offices at Ahwa and at Waghai.

The officials, with the exception of a few who are borrowed from the Government of Bombay etc. are employees of the Dangs administrations and paid from its revenues

There is no system of popular representation but the chiefs and the patels of the villages who number between 300 and 400 used to meet the Political Agent or in his absence the Civil Administrator in Darbar 3 or 4 times a year; and the Resident usually attended one of these functions During the last Darbar which was held on the 15th December 1947 to meet the Executive Council, subsidies consisting of nearly Rs. 9,000 were paid to the *Rajas* and *Naik Sahebs* of Dangs.

In addition, allowances have been paid out and turbans distributed on these occasions for good service *e g.*, in connection with fire prevention or epidemics and a review of the event of the past quarter read. These periodical gatherings supplemented by informal contacts, enabled the Administration to keep in touch with the wants of the people who have been extremely law abiding and co-operative though shy and unassertive. The primary aim of the administration had been to establish the closest personal contact with the 'Dangis' in their villages to avoid formal and bureaucratic methods and over administration with a large staff of subordinates and to spend the increasing revenues of the area on raising the standard of living of the people. Improvements in nutrition, eradication of malaria and other epidemics. and increase of education without destroying the culture pattern of this aboriginal society were considered the primary needs of the area and received the closest attention of the authorities

Forests :—The forests form so *vital* and *predominant* an element in the Dangs, *consisting the culture patterns of the people* and *supplying nearly all the revenue*, that an extended notice of them is called for. The first forest leases were entered into with the Chiefs in 1842 to secure a hold over the territory to maintain order and to obtain the large timber required by the Navy. 466 villages were leased for 16 years, with the option of renewal for an annual subsidy of Rs 11,230. In 1862 the lease was renewed in *perpetuity*, and extended to the *whole* of the forests in the Dangs. the subsidy being increased to Rs. 13,039. In 1869 the first forest settlement took place, under which 217.12 sq. miles were formed into Reserve in return for which the subsidy was raised again to Rs. 17,859 This reservation of forest was, however nominal for many years as the Chiefs and their followers conceived it to be the first step to deprive them of their rights. They therefore hastened to cut down and to cultivate more virgin land. This was a violation of the agreement. To put an end to this steady destruction of the forests, the Bombay Government in 1902, carefully reviewed the whole future of Dangs, transferred political control from Khandesh to Surat, the Collector of which was appointed Political Agent and appointed the Divisional Forest Officer, Surat as Assistant Political Agent for the Dangs with powers of a First Class Magistrate with the result that cultivation was restricted to protected forests Fires decreased and and forests began to fill up again. Mr. E.M Hodson was the first Forest Officer to hold these additional powers and made splendid use of them. Besides stopping fires he drew up and introduced a code of administrative standing orders, many of which are still in force. He also obtained by conciliation and tact the consent of the people to final revision of the Forest Settlement whereby in 1911. 113,81 sq. miles were added to the Reserves.

It appears that previous to the lease entered into in 1842, Government exploited timber from different parts of the Dangs under various arrangements with the Chiefs in some thing like the Share System, the work

being supervised by the "Government Timber Agent " Some of the Rajas also formed timber rights to the Surat merchants, one of whom in 1844 was paying Rs 2700 a year for the Ghadvi Dang alone. At that time, all timber was subjected to heavy transit dues levied by Baroda. There was no limit to exploitation save labour supply and means of transport. Over 3000 cartloads of timber used to come from the Dangs yearly and must have been cut from only the easily accessible parts as logs.

From 1845 to 1878, promiscuous fellings, chiefly of teak, went on, trees being marked by *Karkuns* under the superintendence of forest Inspectors and felled and removed by purchasers; departmental operations were also carried on and considerable quantities of dead teak killed by yearly fires were sold. There was wholesale destruction of *Khair*. From 1877 to 1889 an average of about 600 tons of teak, chiefly dead, was sold standing in the forest, the price received being about Rs. 27,500 per annum; and nearly 500 tons of jungle-wood at an annual price of Rs.10,000. There were also fairly extensive departmental cuttings, the timber being collected and sold at jungle depots There was no regularity. The output of the bamboo removed on permits varied from 1 to 9 lakhs, the timber from hundreds to thousands of tons and the whole revenue being from Rs. 25,000 to over Rs. 80,000.

The demarcation of the reserves which began in 1890 brought no change in the extent of exploitation. The 1st working plan report for the Dangs forest is dated 12th August 1926, much of the field work necessary for this report having been done in 1912-13 and 1914-16. It is prepared for the Reserved and Protected Forests of the fourteen petty States.

Configuration of the ground:-The Dangs are the water-worn remains of a once extensivable land. Beginning on the East with a chain of rugged mountains running up to about 3500 ft. they descend to the edge of Gujarat plain on the West to the lowest level of about 340 ft. The general nature of the country is mountainous

Underlying Rock and Soil;—The system is trap and the rock varies considerably in texture and hardness, blue black to grey when broken These rocks have produced soils varying from red through grey to nearly black. The slopes maintain a fair average of covering but every terrace and bit of flat however big has been cultivated at some time and has suffered from denudation. However, the soil, if not highly fertile, is sufficiently so for large tree growth and offers it a good foothold. The people barely touch the dead leaf covering in Reserves and there are now no fires to destroy it, a great accumulation of dead leaf and bamboo covering remaining to decay all over the forests except on grassy uplands. The soil must therefore be constantly improving on all reasonably well stocked areas.

Climate:—The rainfall is about 67 inches at Ahwa and is heavier just under the ghat line and in the West, East winds prevail in the cold weather and South-West for the rest of the year. There is general scarcity of water during April and May. The climate is notorious for malaria, and outbreaks of pneumonia and influenza are common. The climate is, however, pleasant from January to March and not unbearably hot in April and May.

Agricultural Customs and *Wants* of *People*:- The population is chiefly concerned with cultivation of *Nagli* and to that end the Dangi seems bent on cutting and burning a maximum quantity of branchwood and bamboos for ash manure. Every species of tree including teak is lopped for ash manure in the Protected Forests. The reserves have partially recovered from the time when they were also cultivated. Now a days the damage is not excessive considering that the fields and village sites are included in Protected Forests.

The people are extravagant of land which they cultivate by *Wahiwati* (there is no Survay Settlement) paying a plough tax of Rs. 6 8-0 which is collected for the chiefs by the Dangs Administration. They prefer to shift their cultivation about pretty frequently to get fresh soil and abundant lopping close at hand. They also shift their villages on little pretext.

A good deal of hunting and fishing is done. The Dangi cattle are all agricultural; their numbers are not excessive and they do little damage in reserves. Mohwa flowers are no longer collecled and the liquor is brought in from outside.

The houses are mainly huts of *wattle, daubs* and *thatch* supported by posts, rafters and ridge pieces for which the Dangi is very particular to have teak. They look ramshackle habitations but when in proper repair are vastly more comfortable than they appear.

Water Supply:—This is plentiful in the west Dangs and far up the main valleys. Elsewhere it is precarious particularly the uplands which contain many villages and are so badly off that one wonders at them living there. The main plateau of the Central and Eastern Dangs is especially short of water supply.

Forests Distribution and Area:—The total scaled area of the Dangs is 660.45 sq. miles consisting of 346.73 Sq. miles of Reserves, 304.02 of protected forests and 9.70 of rivers and big nalas. The greatest proportion of reserves is found north of the Purna where it stretches in an unbroken line for 20 miles. Between the Purna and Khapri valleys the Reserves and Protected Forests alternate in great solid masses and south of Khapri the two classes are more jumbled up. The proportion of protected forest increases from west to east.

Composition and *Condition* of the *Forest*:- The Dang Forests consist of big mixed tree growth among which Teak is predominant in number and total bulk though individual jungle woods surpass it in height and girth. The forest is continuous in all parts except where the ground is too steep to retain the soil and where it has been cleared or opened out by man.

The forest has been long overmature; many trees are from 200 - 300 years old. A long period of fires, thefts, shifting cultivation and extraction confined to sound trees has aggravated the effect of overage and the result is partial wreck of what ought to have been the best teak forests in Bombay outside Karana. A certain proportion of the the middle sized trees and even poles are in varying stages of unsoundness Nevertheless an enormous amount of big marketable teak and jungle woods is still left in the forest.

To this old damaged stock has been added a fine crop of teak and better junglewood species varying upto 50 years and sometimes more, by natural as well as artificial regeneration. Teak forms more than 50% of the growing stock and there is marked natural regeneration of teak.

Roads and Buildings:- The Forest Department has also been required to attend to all P W.D. Works and in addition to maintain 363 miles of road viz. metalled 45 miles. murum 23 miles and earth 295 miles.

Lines of Export:- The Tapti Valley Railway runs parallel to the boundary of the North Dangs at a distance varying from 15 to 20 miles. A good metalled road now connects it with the North Eastern Dangs at Subir The G B. S narrow-gauge line from Billimora on B B. and C I. Railway enters the Western Dangs at Waghai whence a well graded metalled road runs right through South Dangs and meets Hatgad-Vani Nasik road at Saputara.

Mode of Extraction:- The extraction is mainly by motor transport from accessible parts where the material is brought by dragging The transport by bullock carts is rather limited.

Labour:-The Bulk of the forest labour is imported from the neighbouring States.

Financial Aspects:- The revenue and expenditure for the last 10 years is as under:-

Year	*Revenue*	*Expenditure*	*Savnigs*
1937-38	5,67,985	1,95,237	3,72,748
1938-39	5,50,201	1,86,540	3,63,661
1939-40	4,41,487	1,72,476	2,69,012
1940-41	5,13,965	1,64,676	3,49,289
1941-42	6,14,458	1,99,433	4,15,025
1942-43	10,01,165	2,41,062	7,60,103
1943-44	11,16,789	2,28,575	8,88,214
1944-45	8,36,730	2,77,588	5,59,142
1945-46	10,32,901	2,71,901	7,61,000
1946-47	18,55,340	2,59,410	15,95,930

The revenue for 1947-48 was over 30 lakhs of rupees.

ON THE APPLICATION OF STATISTICAL QUALITY CONTROL METHODS IN WOOD BASED INDUSTRIES *

BY

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INTRODUCTION

Among the many fields of science which have been stimulated by the war is the *Statistcal* control of quality in industrial materials and products. Quality control has, of course, been practised in industry for generations. But the use of statistical methods in controlling quality is quite recent. The pioneer preceptor and practitioner of this technique is Dr. W.A. Shewhart of the Bell Telephone Laboratories, New York who invented and installed Quality Control chaarts there, somewhere in the early twenties.

Before 1942, even in the U.S.A., applications of statistical quality control were confined mostly to certain plants in the electrical goods industry, in the textile industry and in certain Government arsenals devoted to the production of munitions. Since 1942, many successful applications of statistical quality control have been made in the aircraft, chemical, milling, food-canning and preserving, container and other industries.

The author has not come across any published account of the application of statistical quality control to any forest product industry. But a recent advertisement by a plywood manufacturing Company in the U.S.A. will bear testimony to the fact that statistical quality control is being sucessfully applied in some wood using industries also in that country. The advertisoment runs as follows:—

" N quality control engineering offers ply-wood with

Even Moisture Content. Quality Control, by the statistical methods, is the new sensational industrial engineering development at N

that gives every customer what he orders, with acceptable variations.

Even Thickness. Accurate sampling measurements assure you N Plywood that is not " thick & thin " but is whithin two or three thousandths of an inch of specification throughout the length and width of every panel.

Square Edges. Here, again N Qualiay Control produces plywood that is ready to lay up without reworking. Accurately squared edges always fit"

In India there exists a plywood industry which produces about 6o million sq. ft. of ply-wood annually, against an estimated total internal demand of about 150 millions sq. ft. with the prospect of export to Ceylon and other adjecent countries, a flourishing plywood industry can be organised provided sufficient attention is paid to bring our product to the same level of quality as that of American and other high-quality imported plywood,

Statistical Quality Control,

It is not possible in this article to explain at length the details involved in setting up Statistical Quality Control charts, Engineers and other technical men engaged in manufacture of industrial products could obtain all necessary guidance from the growing literature on the subject.† To avoid confusion the difference between the expressions *Quality Control* or Q.C. and *Statistical Quality Control,* or S. Q. C. needs emphasis. The control of the quality of a manufactured product is a function that has existed all along with or without the application of statistical methods to the analysis of quality data. The expression Quality Control applies to that function and has therefore a broader significance than the Statiscal Quality Control. The use of Statistical Quality Control calls for a new point of view which may be briefly described in the following words of Grant*

> "*Measured quality of manufactured product is always subject to a certain amount of variation as a result of chance. Some stable " system of chance*

* This article has been written in response to an invition from the Sectional Committee on Quality Control and Industrial Statistics of the Indian Standards Institution. The title suggested by the Sectional Committee was "The application of Statistical Quality Control methods in Forest Research." but as that title did not appear to be quite appropriate a slightly modified one has been adopted.

† "A Bibliography of Statistical Quality Control" by Grant I. Butter-baugh, published for the Bureau of Business Research of the College of Economics and Business by the University of Washington, Seattle, 1946.

causes" is inherent in any particular scheme of production and inspection. Variation within this stable pattern is inevitable. The reasons for variation outside this stable pattern may be discovered and corrected.

The power of the Shewhart technique lies in its ability to separate out these assignable causes of quality variation. This makes possible the diagnosis and correction of many production troubles and often brings substantial improvement in product quality and reduction of spoilage and rework. Moreover, by identifying certain of the quality variations as inevitable chance variations, the control chart tells when to leave a process alone and thus prevents unnecessarily frequent adjustment that tend to increase the variability of the process rather than to decrease it.

Through its disclosure of the natural tolerances of a production process, the control chart technique permits better decisions on engineering tolerances and better comparison between alternative designs and between alternative production methods. Through improvement of conventional acceptance procedures, it often provides better quality assurance at lower inspection cost."

Specification, production and inspection are the three main functions in terms of which all matters related to the quality of a manufactured product can be examined. Statistical quality control should be viewed as a tool which may influence decisions related to these three functions,

Variation in quality of timber as a raw material of industry.

The industry uses of timber are on the increase. In the words of an American expert "Wood is now plasticized, moulded, laminated, impregnated and spun into such a variety of human uses that technicians are writing of it as the *Universal raw material.*"

Being a biological product timber is liable to considerable variation. At present, there are many industries in India which use timber as a raw material but seldom take into consideration the fact that it varies from tree to tree and piece to piece. As a result, on the one hand the industries experience considerable difficulty in handling this raw material satisfactorily, and on the other the finished articles show great difference in their quality,

Apart from the technique of manufacture the machinery used etc, the quality of a finished article mainly depends on the raw materials used. In the case of timber, the seasoning properties, natural durability, amenability, to preservative treatment, physical and mechanical strength properties and working qualities vary from species to species.

It should, thus, be apparent that the problem of standardization of the qualities desired in any particular wood-based product is more difficult and much more important than in products which use uniform materials like steel or other metals. The utmost care is therefore necessary in the selection of raw materials.

Work done up to date, of help in Quality Control.

The Forest Research Institute at Dehra Dun has carried out much fundamental work on Indian species of timber, has worked out rules and sepecifications for the selection and grading of these species, and has indicated the most suitable species for particular wood products. The wood products so dealt with include structural timber, railway sleepers, telegraph poles, piles, veneers for plywood, tool handles, textile mill accesories (shuttles, bobbins picker arms etc.), aircraft timber, battery separators, pencils, match splints, etc. The general finding of all these investigations is that timber should be properly selected and suitably seasoned for all uses, and, in some cases, treated with preservative, if the products made out of timber are to give long and efficient service.

The Forest Research Institute has also taken a hand in improving and standardising the quality and design of such *finishing articles* of wood as packing cases (ammunition boxes, tea chests, etc,). As a result of tests on several types of existing packing cases many improvements in their design have been recommended. If these recommendations are included in their specification of packing cases, it would help to establish the *packing case industry* on a sound basis.

Plywood tea-chests are manufactured in India from various, timbers such as hollock (*Terminalia myriocarpa*,)hollong(*Dipterocarbus pilosus*), mango (*Mangifera indica*), semul (*Bombax malabaricum*), pali (*Palaquium polyanthum*) etc. Hollock and hollong however are the

* Statistical Quality Control, by E. L. Grant, McGraw-Hill Book Company, Inc., New York and

ecies most used; they grow in the forests of aspsam which isa n important area fcr production of tea. Boxes of various makes from all these timbers are, from time to time. subject to 'model service tests, in the Timber Testing Section of the F.R.I. and advice is given to the manufacturers for improving their products

Work on specifications for seasoning, preservatives, adhesives, etc.

To cope with the continued increase in the demand for timber, Government or private commercial corporations in India will have to set up, sooner or later, seasoning kilns and preservative plants throughout the country. In the U.SA. more than five thousand commercial kilns now employ the internal fan system of controlled drying (invented by the Forest Products Laboratory, Madison), to season lumber rapidly and safely. When such methods of seasoning or suitable variations of the same are standardized for our own species the requirement there will arise the need for using statistical quality control methods to check whether the seasoned timber specifications as regards moisture content and other measurable qualities are in order.

From the point of view of strength properties wood has been found suitable for many purposes for which steel,concrete, etc., are used at present. But being a biological material wood deteriorates comparatively quickly, especially the sapwood which is highly susceptible to attack bv fungi and termites and other insects. The duration of its efficient service can be considerably increased, however, by impregnation with suitable preservatives. Toxicity tests and accelerated service tests are used for developing proper specifications for compositions and absorption of preservatives. Considerable work has been accomplished in the Forest Research Institute on the use of preservatives for treating wood for railway sleepers, transmission poles etc.). When preservative plants are set up and the preservatives are applied by a standard process according to specifications of measurable qualities, such as, extent of penetration, absorption, etc,, these qualities could be subjected to statistical control.

In many modern industries the use of wood involves necessarily the use of adhesives. The present specifications used for the testing of adhesive are B. S. S. 647 for animal glue and B.S.S. 4v2 for casein glue. The onlv Indian specifications for glue (and plywood) are the ones recently issued by the Directorate General of Industries and Supplies for commercial plywood and tea chests. They are only provisional. Further work will help to finalise these specifications but the first step here is to locate a *suitable* Indian timber (in place of beech) for use as test slips. In this connection, work is in progress in the Forest Research Institute.

It has been found that laminated resin treated wood (impreg.) is superior to normal wood in dimensional stability, hardness, electrical resistance etc. Laminated resin-treated and compressed wood (compreg.) has also been developed having similar stability but greater hardness. There are no specifications for these different types of composite wood made from Indian timber. Work on the various properties of these products is in progress. Further work and statistical anaylsis of the results would *help in arriving at the range of variation to be* expected for various species and treatments, and also in drawing up suitable specifications.

Standardization, the primary need.

The crying need of the day, therefore, is standardization, and statistical methods play an important part in that field. It is no use drawing up standards of specification which the industry finds impossible to conform to. By settling up quality control charts to give a running commentary of the *average* quality of the product and the *variability* in that quality determined from a few specimens examined at or near the machine during patrol inspections, it will be possible to discover whether the specification needs amendment or whether it is the machine or process which needs adjustment.

In India, we have to start almost *de novo* on the problem of standardization. So far as the timber industries are concerned, the F.R.I. will have to play a central role to assist the Indian Standard Institution in the drawing up of provisional specifications. The newly created Statistical Branch in the F.R.I. is ready to examine the statistical basis for all these specifications. The recent setting up of a committee for timber product under the I. S. I., in which officers of F.R.I. have been included, is a move in the right direction and is in keeping with the system obtained in countries of the West. To quote from a paper, presented to the Fifth British Empire Forestry Conference held in Great Britain in 1947, by the Superintendent of the Forest Product Laboratories of Canada -

"In addition to carrying on research projects, members of the Laboratory staff serve on many Industrial and standardizing committees. Among these might be mentioned the Executive Committee of the Canadian Standards Association and the Committees of this Association engaged in setting up stand-

ards for structural timber, telegraph poles, piling, wood preservation, prefabricated construction, packing codes, and wood fibre insulation."

Standardizatien of local and trade names of tree species.

One of the first tasks that confronts the newly formed Committee on timber products of the I.S.I. is the standardization of trade name of species of Indian timber over which much confusion prevails at present because of many local names in different provincial languages.

In a forword to its standard list, the British Standards Institution says;

> "In specifications and contracts, where accuracy may be a matter of vital importance, reference to a standard name in the Nomenclature should eliminate all risk of misunderstanding on either side"

The *Nomenclature* list for *soft woods* B.S. No. 539 1930 and for *Hardwoods* B.S. No. 881 1939 drawn up by the B.S I. and revised in 1940, covers timbers of all countries which enter the British market, including a few Indian species. The list, as published in the Empire Forest Handbook 1946, gives the following information:

Botanical name & family.	Standard name	Soure of supply	Remarks	other names	average weight in lbs per cub. ft. at 15% moisture cotent.

There is a good amount of data in the F.R.I. to help in preparing a similar 'nomenclature for Indian timbers. The I.S.I. may even go a step further and give an estimate of the standard error of the average weight in lbs. per cub. ft. Since the average weight of the same species may vary from locality to locality separate averages and standard errors by localities may have to be given for each of the main sources (regions) of supply.

In conclusion, so far as Indian Industries using timber are concerned. we are in a very backward position, to discuss S. Q. C. in any detail for these industries at the present stage will be 'putting the cart before the horse'. The fact has to be faced that there is no organised, timber industry' worth speaking of at present in India. Since most of our forests are state owned, the organisation of any 'timber industry' on western lines will depend, at least initially on the interest the Government takes in its organised development.

A NOTE ON TROPICAL KUDZU

By Mr. D. C. KAITH, B Sc., (Edin.)

Forest Officer on Special duty, Ministry of Agriculture, Government of India.

S/44/3n., G/1113/Gn , G/2612/Gn.—Tropical Kudzu is described and its characteristics explained in detail for artificial introduction in India.

Tropical Kudzu is becoming an outstandingly important plant in erosion control all over the world. This note has been prepared from various publications of the United States department of agriculture for those interested in soil conservation work in India.

There are two important species of Kudzu namely (1) *Pueraria thunbergiana* (sieb and Zucc, Benth) and (2) *Pueraria phaseoloides* (Roxb) Benth. The latter is known as Tropical Kudzu which may prove of greater importance to India. Kudzu proper is being planted in southern states of North and South Carolina, Georgia, Florida, Lousiana and is doing well.

Tropical Kudzu (*P. phaseoloides*) is being used in Malaya, Java, Sumatra, Liberia, Nothern Australia, South China and Ceylon for ground cover to prevent soil erosion. It is probably a native of S.E. Asia. It was introduced into Puerto Rico in 1940 by the Soil Conservation Service of the United States department of Agriculture. The Division of Plant Exploration and Introduction of the U,S,D A., got tropical Kudzu seed from Darjeeling, India in 1910, 1919 and 1933. Seed was also obtained from Sumatra, Java and Ceylon.

Pueraria phaseoloides has been described by F J. Hermann, associate botanist, Division of Plant Exploration and introduction of the U.S.D.A , as follows:—

Pueraria phaseoloides (Roxb) Benth. (Fabaceae)

* The only exception may be the plywood industry which though far from well established has an organisation of some kind.

A twining vine, clothed with dense spreading brown hairs; leaves trifoliate; stipules small, lanceolate, basifixed, leaflets membranous green and thinly clothed with appressed hairs above, grey and more or less densely matted beneath, terminal leaflet very variable in size and shape, usually broadly obvate to rhomboidal, entire or rarely semewhat 3 lobed, 6-5 centimeters long; flowers in long peduncled racemes; pedicels 3-8 millimeters long, bracteoles lanceolate, 2-3 millimeters long; strongly nerved, strigose and hirsute; calyx 5 millimeters long, strigose and bristly hirsute, the teeth 1.5-2 millimeters long, broadly oblong and abruptly acute except the lowermost which is lanceolate with setaceous tip; corolla deep to light lavender, often with whitish fringes, 15 millimeters long, blade of standard roundish, distinctly spurred; pod 6-10 centimeters long, 4 millimeters wide, black when ripe, trigose rather turgid 15-20 seeded.

Tropical Kudzu is a deep rooted leguminous vine which takes root at nodes and in favour able circumstances grows and spreads all over the ground. It is an ideal crop for soil erosion control. It grows and seeds best in Puerto Rico where minimum rainfall is not less than 50 inches a year from sea coast up to 3000 feet in the mountains. It is killed by frost. It is perennial and grows all the year round. It grows well on heavy clay soil with pH 5.0. also on sandy loams.

Kudzu can be propagated from cuttings or seeds. Seed can be sown in hoed lines or patches. Cuttings can be planted 3″ × 3″ in prepared ground with the advent of the rains in June and July and as late as September. Seed viability usually remains above 90 per cent germination for at least one year or longer. Seed sown after soaking for 24 hours in water, germinates within 10 days. It is generally recommended that legume seeds be inoculated with correct nodule forming bacteria before planting espacially in fields where no legumes have recently been grown. Simple methods of inoculating seed is to collect some soil from a Kudzu field, powder it and dust a few pounds all over the field to be planted with Kudzu. Or a few pounds of soil mixed with water allowed to settle in a bucket of water, containing nodule bacteria is taken out and poured into the bucket containing Kudzu seed which is then sown.

If seed is dibbled in patches 3 feet apart, 5 lbs. of seed are required per acre. If 18″ x 18″ spacing is adopted using a pinch of 10-12 seeds per patch one pound of seed will do. Tropical Kudzu flowers and seeds from November till March. Seeds are dark brown to yellow. Number of seeds is 3600 to a pound.

Kudzu is an excellent plant for filling up gullied areas. As fodder, cattle like it. It is estimated that about one acre of tropical Kudzu will feed one cow continuously during the dry season and two cows during the rainy season. Over grazing of Kudzu pasture should be avoided. An acre will produce 12-20 tons of green fodder.

When planted in the neighbourhood of tree plantations, care must be taken to keep it in check against climbing on saplings which might be smothered and killed. Seed of tropical Kudzu can be obtained from the Director Federal Experiment Station in Puerto Rico, Mayaguez, Porto Rico. U. S. A. Trial of this variety at different centres in India are being planned in co-operation with the State Research centres

A NOTE ON THE CULTIVATION OF KAPOK

A. SANKARAM
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Few Indian farmers are aware of the economic utility derived and the aesthetic sense afforded by systematically planned and well maintained farm roads and avenues. Government or State farms that demonstrate this, have often been misconstrued by visitors as waste of space and expenditure involved in maintenance. Practical and financial disabilities have often been cited by some farmers as potent reasons for neglect of this aspect of farming. But even under situations where conditions are favourable there is no attempt on the part of the farmers for satisfaction, much less for pride. A plea for development in this direction is the object of this note, with special emphasis on kapok which as an avenue tree on farm roads, fences and wide bunds is admirably suited as it effectively combines economic utility and ease in cultivation. In what follows is presented a short account of the cultivation and economic uses of kapok.

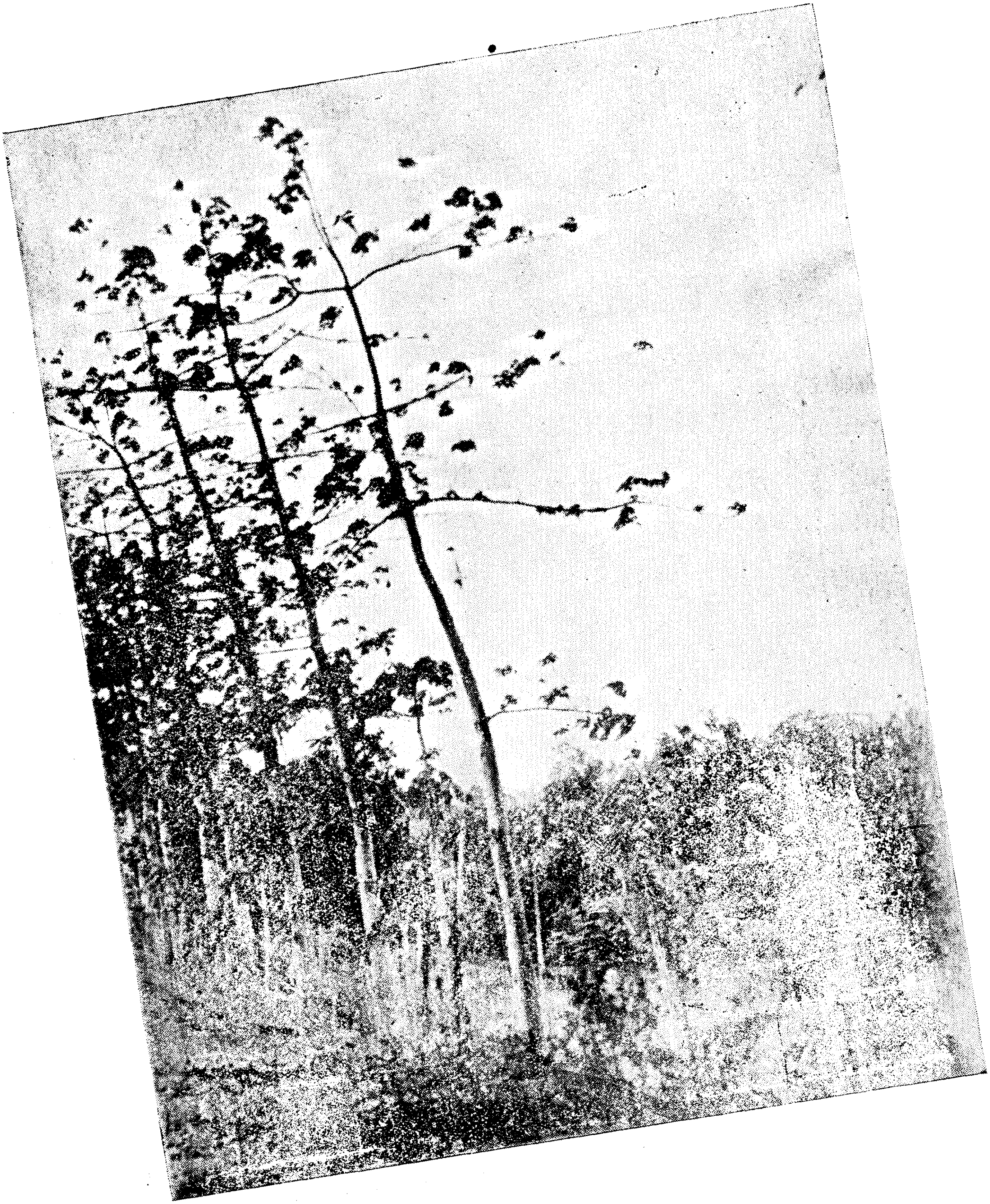
KAPOK PLANT DESCRIBED:— Eriodendron pentandrum Kurz. belongs to the family Malvaceae. It is a tall growing tree with smooth green stem and horizontal branches arranged in whorls. This affords the tree a characteristic peculiar aesthetic sense to observers. It sheds its leaves during the dry season

and as the new leaves appear the beautiful white flowers emerge out in axils and show themselves off very well in the deciduous condition of the tree. The fruit is more or less an oblong capsule or pod about six inches long and two inches in diameter at its greatest width. The hairs (fibre) arise from the inner walls of the fruit and not from the seed as in cotton. This is of special advantage in the commercial preparation of the floss as it enables the separation of the naked seed from the floss by simple manipulation with hands. A method of separation of seed from the floss by a simple technique of " churning " the material in a pot gave encouraging results. The seed easily gets collected at the bottom of the pot leaving the floss.

KAPOK CULTIVATION PROCEDURE: The tree although found in a wild or semi-wild state from the sea level up to an altitude of 3,000 feet shows its best performance when grown at elevations less than 1,500 feet above the mean sea level. The prevelance of low temperatures over long periods is said to inhibit the growth of the tree and development of the fibre. It does well in the tropics. A climate characterised by an abundant rain fall during the growing season and a dry period from the flowering to harvest is the desideratum. A well drained loam with deep sub—soil is best suited for successful growth. The tree is easily propagated from either seed or cuttings, but the general opinion is in favour of propagation by seed. The seed does not require any resting period and is known to lose its viability after a year. The seed is to be sown six inches apart in a nursery on raised beds in the month of June with the break of the South West monsoon Germination starts three to four days after sowing and reaches completion after a week. The seedlings in the early stages are to be shaded under plaited Coconut leaves for about a month and then exposed to the sun. During a period of eight weeks from the time of sowing the plants grow to a height of nine inches when they are ready for transplantation to permanent quarters. The seedlings should be carefully lifted from the ground without loss of any roots and should be topped and the leaves removed. They are to be transplanted immediately into pits dug out at 18 feet apart. Transplantation should preferably be done on a cool rainy day. Till they get well established here and begin to grow great care must be taken to pot—water them as and when found necessary. They grow to a height of 3 to 4 feet within six months from the date of transplantation when no further care is necessary, except to prevent browsing and trespass by cattle, goats and sheep. After a period of four years the plants begin to bear fruit and yield floss in small quantities at the commencement. The yield rises gradually and reaches a peak by the 9th year age of the tree. Thereafter Kapok trees are known to yield for about 20 years or more. An average tree yields 800 to 1,000 pods fetching four to five pounds of the floss and about 2 lbs. of the seed. Nearly 500 seeds go to make an ounce. Still higher yields of the floss are known. The trees are not known to suffer seriously from the ravages of any pest to merit attention.

MULTIFARIOUS USES OF KAPOK:— The silky floss attached to the inner walls of the capsules of certain plants belonging to the families Malvaceae, Apocynaceae, Asclepiadaceae have for a long time been known to be of use as stuffing material in upholstry, Of these kapok is the most important and highly valued. The use of the term kapok should be restricted to the floss derived from *Eriodendron pentandrum Kurz.*, though at present it is used in a wider sense including the floss derived from many other plants. Kapok consists of cylindrical one celled brittle hairs. It is light, bouyant, elastic and has a smooth surface. It is six times lighter than cotton and being resilient does not get matted under pressure. According to Annon (Sci. American 1914) " the waxy coating on the fibre which gives it the glossy appearance is not said to be pleasing to vermin" - Kapok matress is therefore known to be vermin proof. Its chief use is for stuffing couches, cushions, pillows, matresses and similar articles. Its resilient nature and none hygroscopic properties make it the best material for upholstery. During the period of war its importance increased considerably as it was found to be much superior to cork or reindeer hair for making lifebuoys, lifebelts and other naval life saving appliances. The floss of *Calatropis* is sometimes used for adultrating the kapok. From the bark of the tree a medicinal gum is obtained; the wood is employed as tanning material for leather. An inferior bast fibre is sometimes prepared from the bark of the tree.

Kapok seed is rich in oil and the oil expressed from it is used under the name " Kapose oil " The oil is expressed on a commercial scale in Holland from the material imported from Java. The yield of the oil from the seed on a commercial scale is 17.8% whilst by extraction with ether 24.8%. The oil is greenish yellow or reddish coloured and has a great resemblance to cotton seed oil in its general properties but dries more rapidly than cotton seed oil. The residual cake after expression of the oil is useful both for livestock and to the



soil as a manure. The leaves of the tree are greedily eaten by cattle, sheep and goats. Thus the tree has wide uses to merit attention for its increased culture.

AN EXAMPLE AT A.R.S. SAMALKOTA:- In the year 1932 a batch of seedlings of kapok were planted on a wide bund running parallel to the road leading to the farm. This row of plants are well grown now and yield a valuable floss; and thus exemplify the utility of such bunds which otherwise would have been waste of space. Besides the aesthetic sense afforded, this row of trees never failed to attract even the busiest or most absent-minded passer by. It is seen from the data presented in the table that the income from the trees is of no small magnitude, especially as no care or attention is bestowed to wards them.

Table I. Yield of floss and income. A.R.S. Samalkota.

Particulars	1397	1938	1939	1940	1941	1942
Yield of floss (lbs.)	16	24	37	55	70	80
Income at 12 annas per lb. (in rupees).	12	18	27—12	41—4	52—8	60

Note:—(i) Total number of yielding trees. 22

(ii) Cost of maintenance is practically nil.

(iii) The value of the seed is offset against the picking of the pods and the preparation of the floss.

A PLEA FOR ENCOURAGEMENT :— From what has been presented above the potentialities of kapok as a tree of great utility to farmers for planting in their home farms either on wide bunds or in the fence are clear beyond doubt. Its possibilities for development are high in Circars (Madras) as it lies in the tropics a climate admirably suited for its culture. It is grown on a wide scale in Tanjore, Madura (Periaknlam) Ponneri (Chingulpet) as a result of which farmers get very fair and encouraging returns. With little care in the beginning kapok trees get well established and need no further attention; while they contribute annually substantial sum to the grower. To give wide publicity of this little - known plant and to put a strong plea for its inclusion in any comprehensive tree plantation programme for farmers in the rural areas are the objects with which this short note is written, and if these objectives in any measure have been attained the writer will feel very happy and amply compensated for the effort made.

ACKNOWLEDGMENTS :—I am deeply indebted to Sri S. N. Chendrasekharan, M. A., Government Lecturing and Systematic Botansit, Agricultural College and Research Institute, Lawley Road P.O., Coimbatore, for all the help received in the prepration of this note.

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NEW OR LITTLE KNOWN PLANTS FROM ASSAM

By R. N. CHATTERJI & M. B. RAIZADA, F.R.I., DEHRA DUN.

The plants referred to in the following pages formed part of a collection made by Dr. N. L. Bor., C I. E., I. F. S., (Retd.), mostly during 1942-45, from various parts of Assam, particularly the Khasi and Jaiantia hill tracts. The area covered includes districts of Nowgong, Sibsagar, Lakhimpur, Goalpara, Sylhet, Manipur together with Garo, Khasi, Jaiantia, Naga and Mishmi hills.

The flora of the province of Assam, more or less comprehensively dealt with by Kanjilal, Das and others, and the series of articles by Fischer on "Plants new to Assam" which appeared in the various issues of the Kew Bulletin, have minimised the chances of coming across new or undescribed species. Scattered papers on the flora of the province were looked up in the Records of the Botanical Survey of

India, Journal of the Asiatic Society of Bengal and other scientific journals. The species included here are such as have not found mention in the above noted publications, including Hooker's Flora of British India, as having been definitely reported from Assam.

For the advantage of scientific workers, it has been thought desirable to add detailed descriptions of plants not provided in the Flora of British India by Sir J. D. Hooker, or scientific details of such plants as are not easily accessible to the ordinary reader. In certain cases the diagnoses of plants, available in Latin or French only, have been rendered into English in order to make the paper an easy reference.

The present contribution embodies the names of about 30 species of plants (herbs, shrubs, climbers & trees) already described but now recorded for the first time from Assam.

A new species of *Senecio* from Viswema, Naga Hills, was discovered in this collection. The description of the plant, *Senecio borii* Raizada sp. nov. is being published separately.

All the plant specimens listed here are deposited in the Dehra Dun herbarium.
Corydalis chaerophylla DC. (Fumariaceae)

F.B.I. 1126.

Known from temperate Himalaya 6–10,000 ft. Sikkim to Kumaon. Dzulske Valley, Naga Hills, 8,000 ft. September 1939 N. L. Bor's collector 8446.

Kohima, Naga Hills, July 1942, N. L. Bor 16030.

Herb. "A somewhat tall *Corydalis* in dense evergreen forest ".

Reevesia pubescens Mast. (Sterculiaceae) F.B.I. I.364.

Known trom Eastern Tropical Himalaya; Sikkim; Bhotan.

Shillong Khasi and Jaintia Hills, May 1944, N. L. Bor 18181.

Kohima, Naga Hills, April 1945, N. L. Bor 18476.

There are two old specimens in the Dehra Dun herbarium collected by Dr. King's collector and Gustav Mann from Assam.

"A middle sized to small tree with fragrant flowers. Corolla white tinged with pink."

Meliosma forrestii W.W. Smith in Notes Royal Botanic Garden, Edinburgh × (1917–18) 52 (Sabiaceae).

Known from China, Yunnan.

A large shrub or a tree, 6-12m. high. Branches densely fulvous-tomentose. Leaves simple, alternate or sub-opposite, 18-35 cm. long, 7–16 cm. wide, more or less elliptic or oblanceolate, sub-abruptly and shortly acuminate, base cuneate, margin coarsely spinulose-toothed generally in the upper half of the leaf, coriaceous, glabrous above except along the nerves which are sparingly tomentose, lower surface pubescent or tomentose, fulvous-pilose along the nerves; nerves 12-20 pairs, parallel, ending in marginal teeth, thinly sulcate on the upper surface, prominent on the lower surface; petiole 1.5-4 cm. long, densely pubescent. Inflorescence a branched, terminal panicle, dense-flowered, 20-40 cm. long or longer, densely fulvous-tomentose Flowers small, sessile, (immature) cream yellew; bracteoles 3, unequal, densely villous. Sepals 5, unequal, imbricate, sub-orbicular, concave, about 1 mm., hairy with ciliated margin. Petals 5, unequal, sub-orbicular, glabrous, Stamens 5, 2 perfect; anthers globose. Disk cupular, 5-toothed. Ovary sessile, glabrous; style subulate; stigma simple, punctiform.

Dzulake valley, Naga Hills, 8,000 ft., September 1939, N.L. Bor, Dehra Dun Herbarium No, 91597.

In addition to the above we have seen two more sheets of this species—J.S. Gamble 9704 from Phuking, Darjeeling, in Herb. Dehra Dun and G. Forrest 18386 from Yunnan, in Herb Calcutta.

It is the first record of the species from India.

Crotalaria albida Heyne (Leguminoseae) F.B.I. 11.71.

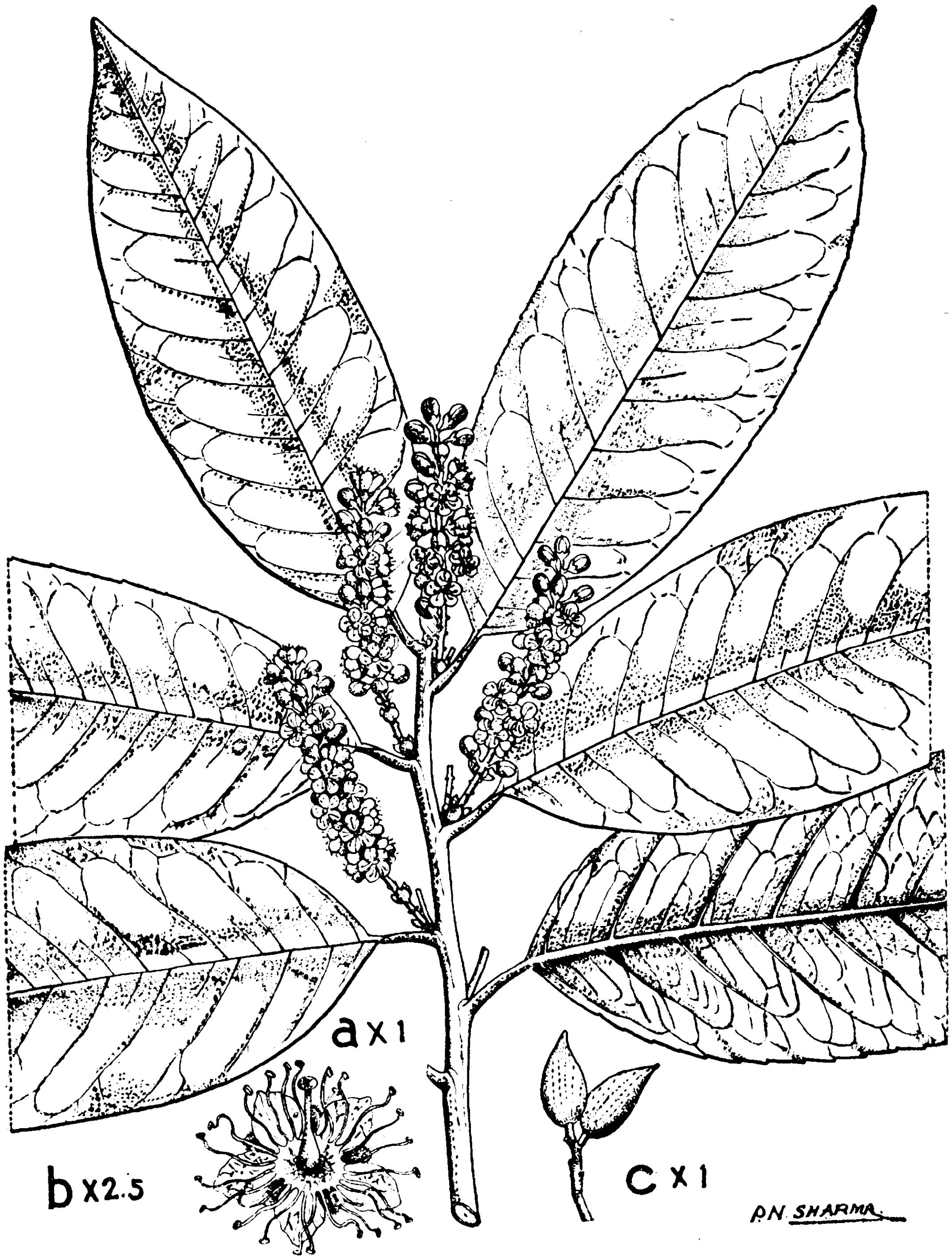
Hitherto reported from various parts of India but not from Assam.

Dimapur, Naga Hills, September 1945, N.L. Bor 18410,

Also there is an old specimen in the Dehra Dun herbarium collected by Gustav Mann from Assam.

A shrub. Flowers yellow.
Crotalaria calycina Schrank (Leguminoseae) F.B.I. 11.72.

PLATE 1



PRUNUS MACROPHYLLA SIEB et ZUCC.

Known from Himalayas to Ceylon, ascending to 5,500 ft. in Kumaon.

Dzulake Valley, Naga Hills, 8,000 ft. September 1939, N.L. Bor — Dehra Dun herbarium No. 90564.

There are three more sheets in this herbarium, collected by Jenkins, Masters and others from Assam.

An undershrub. Flowers pale yellow.

Crotalaria bracteata Roxb. (Leguminoseae) F.B.I. 11.83.

Known from Bhotan, Chittagong, Burma.

Naga Hills, 1935, N.L. Bor 5321.

Losami, Naga Hills, 5,000 ft., July 1942, N L. Bor 16022.

"A small shrub with yellow flowers".

Millettia dorwardii Coll. and Hemsl. in Jour. Linn. Soc. XXVIII (1891) 40 (Leguminoseae).

Known from upper Burma, Kachin Hills, Bhamo and Shan States.

Big scandent shrub. Young parts densely pubescent; stem scabrid brown Leaves pinnate, 15-25 cm. long, petiolate; rachis thinly hirsute; stipules linear, 4-5 mm. long, ultimately deciduous; upper leaflets laterally ovate to ovate — oblong, bluntly obtuse, somewhat acuminate, base obtuse, 6 11 cm. long, papery, glabrous on both surfaces, reticulately veined, nerves 6-9 pairs, prominent on the underside; petiole 3-5 m.m. long; stipellum setaceous 2-2.5 mm. long. Panicles terminal, stout, 12-18 cm long, rachis, branches, pedicels, calyx, and outer side of standard densely, appressedly silky hairy, branches many flowered. Flowers single on the stalk, verticillately arranged, 1.8—2.3 cm. long; pedicels 5 mm. long. Calyx campanulate, minutely toothed, ultimately rounded. Standard ovate, base somewhat cordate and inflexed; palae short, falcate; carina very much falcate. Stamens diadelphoús. Disc tubular, short, crenulate. Ovary linear, pubescent, with many ovules. Immature pods oblong, turgid often beaked, 9 cm. long, 3 cm. wide, 1 cm. thick, velutinate, 2-seeded.

Flowers in May; fruits in October.

Naga Hills, 1935, N.L. Bor. 6272.

Shillong, Khasi and Jaintia Hills, 4,700 ft. June 1943, N.L. Bor 17853

"Flowers silky, pink outside and dark crimson inside".

Uraria lagopodioides (L.) Desv. syn. *U. lagopoides* DC. (Leguminoseae) F.B.I. 11.156.

Known from Nepal, Bengal to Ava.

Naga Hills, 1935, N.L. Bor 6400.

Sakhabama, Naga Hills, 3,000 ft., July 1942, N.L. Bor 16197.

Palel, 2,400 ft., Manipur State, October 1943, N.L. Bor 17750.

There are also two old specimens collected by Jenkins from Assam in the Dehra Dun herbarium.

"A prostrate shrub. Flowers pink to purple-red".

Caesalpinia sepiaria Roxb. (Leguminoseae) F.B.I. II.256.

Reported from various parts of India but not from Assam.

Naga Hills, 1935, N,L. Bor 2794 and 2940.

Manipur State, March 1944, N.L. Bor 18361.

A scrambling pubescent shrub. Stem prickly. Flowers yellow.

Prunus macrophylla Sieb. et. Zucc. in Akad. Muench IV. II (1843) 122. (Rosaceae)

Native of South China and Japan, also reported from Burma.

Tree. Branches and branchlets atropurpureus or cineraceous, with sparsely distributed minute lenticels; stem sometimes longitudinally fissured. Leaves, in dry specimens, viridescent chartaceous, oblong to ovate-oblong, 6.5 — 23 cm. long, 3 — 8 cm. wide, glabrous on both surfaces, apex cuspidate — acuminate-to cuspidate — acute or obtuse, base cuneate-obtuse to obtuse, margin serrulate or entire; mid-rib on the upper surface somewhat raised, thinly sulcate, lateral nerves 7-12 pairs. Petiole 7 mm. — 1.5 cm. long, with 2 opposite glands situated above the centre of the petiole; glands reddish, elevated, cupuliform, about 1 mm. diam. or glands absent; stipules caducous. Inflorescence spicate, spikes in the axils of leaves at the top, solitary or fascicled, sometimes ramose, 4-5 cm. long; flowers

0.5-1 cm. wide, clustered, rachis villous — hirsute; bracts at the base of the pedicels, caducous, scarious, ob-ovate 1.5 mm. long. 2 mm. wide villous-hirsute apex obtuse; pedicels small, 1-3 mm. long, hirsute. Calyx broadly campanulate, 6 mm. diam; teeth 5, broadly triangular, apex acute to obtuse, externally hirsute, internally glabrous, margin ciliolate. Petals 5, inserted at the top of the calyx tube, alternating with the calyx teeth, ob-ovate, 2-3 mm. long, broader than long, apex broadly-rounded, base broadly-cuneate, margin entire, ciliolate or not, glabrous on both surfaces, cream coloured or white. Stamens indefinite, inserted at the mouth of the calyx-tube, arranged in two series; anthers reniform, emarginate; filaments free, glabrous, complanate, base somewhat triangular-dilated, apex narrow-subulate, glabrous. Ovary free at the bottom of the calyx-tube, ob-ovate or oblong, glabrous; style columnar, straight or recurved, 3 mm. long, apex stigmatose; stigma peltiform, more or less oblique-oblong. Ovary 1-loculate with 2 ovules.

Naga Hills, 1935, N.L. Bor 2717.

Jatsoma, Naga Hills, November 1942, N. L. Bor 17294.

"A tree 30 m. tall with cream-coloured flowers."

It is the first record of this species from India.

Cnidium monnieri Cuss. Syn. *Selinum monnieri* L. in Mem. Soc. Med. Par. (1782) 280. (Umbelliferae).

Native of Europe.

Herb. Stem furrowed. Leaves bior tri-pinnatisect; leaflets linear. Involucre multi-foliate; petals obvate, emarginate; fruit obovoid oblong; achenes with prominent ribs, smooth, grooves with a narrow band.

Kamalbari, Darrang District, April 1943, N. L. Bor 17361.

Kamalpur, Nowgong District, May 1944, N. L. Bor 18178.

There are also three old specimens in the Dehra Dun herbarium, collected by Jenkins from Assam.

" A small white flowered herb in wet and waste places."

Hedyotis pinifolia Wall. (Rubiaceae) F.B.I. III. 60.

Known from Bihar and Chota-Nagpure 1-2,000 ft.

Naga Hills, 1935, N. L. Bor 6326.

Kohima, Naga Hills, 4,500 ft., June 1942, N. L. Bor 16208.

"A small white flowered herb".

Knoxia valerianoides Thorel ex Pitard in Fl. Generale de L'Indo-Chine 3 (1923) 288. (Rubiaceae).

Known from Cambodia, Cochinchina, Yunnan.

A dense perennial herb with dark stems. Stem erect, stiff, not branching, sub quadangular, hollow, with 4 longitudinal grooves, brown, more or less pubescent at the top. Leaves opposite, sessile, 5-10 cm. long, 5-30 mm. wide, linear-oblong, oblong, ovate-lanceolate, linear attenuated and pointed at the tip, rounded or cuneate at the base, olive-green and glabrous on the upper surface, more bright-green and generally pubescent on the lower surface, coriaceous; nerves 5-7 pairs, abruptly ascending, more prominent on the lower surface; stipules more or less connate with the base of the leaves, cleft almost to the base into linear-lanceolate, pointed segments. Inflorescence an unbelliform cyme, axillary as well as terminal; cymes wholly contracted, 1-1.5 cm. wide; pedicels short. Flowers dimorphous some with short corolla-tube while others with longer tubes. Calyx-tube ovoid to turbinate; teeth 4, ovate-acute, sub-equal. Corolla-tube long or short, somewhat widened in its upper half, glabrous outside, villous within; lobes 4, valvate with thickened, pointed, inflexed tips. Stamens 4, inserted on the widened portion of the tube, included or exserted; filaments short in some flowers and fairly long in others, partially adnate or not to the tube; anthers linear-oblong. Ovary bi-locular; style slender long or short, stigmas 2, short, divergant, included; ovule one in each loculus, pendant. Fruit not seen.

Kangpokpi, 3,000 ft., Manipur State, September 1943, N.L. Bor 17949.

"In grassland, flowers whitish-purple."

It is the first record of the species from India.

In Cochinchina, according to Pitard, it is employed in the distillation of alcohol from rice, to promote fermentation.

Vernonia teres Wall. (Compositae) F.B.I. III. 229.

Known from Tropical Himalaya, from Kumaon, 5,000 ft., to Sikkim, Bihar, Central India, Burma.

Naga Hills, 1935, N. L. Bor 46.

Dzulake Valley, Naga Hills 8,000 ft., October 1939, N.L. Bor Dehra Dun Herbarium No. 96805.

Maram, Manipur State, 6,000 ft., October 1943, N. L. Bor 17702.

A shrub with blue to purple flowers.

Eupatorium glandulosum H. B. K. Nov. Gen. et. Sp. IV. 122 (Compositae).

Native of Jamaica and Mexico.

Shrubby plant, 3-6 ft., reddish, branched. Branches cylindrical, densely glanduiar, with short, stipulate glands, glabrous. Leaves opposite, petioled, rhomboid-ovate, sharply pointed, coarsely serrate above the cuneate base and 3-nerved below nearly glabrous above, hispidulous along the nerves and glabrate beneath, obscurely glandular and with stipulate glands on the petiole and lower part of the margin. Corymbs fastigiate-trichotomous; heads 40-70 flowered, clustered, pedicellate, fragrant; receptacle flate; involucral bracts lanceolate, acuminate, striate, glandular-ciliate, mostly subequal with scarious margins; corolla white, abruptly dilated; achenes black, glabrous, crowned by a pappus of ten to twelve white scabrid hairs, twice as long.

Shillong, Khasi and Jaintia Hills, 4,000 ft., April 1943, N L. Bor 16063.

"A herb with white flowers gregarious in pine forest."

Some years ago it was cultivated in the Botanical experimental area New Forest, Dehra Dun, and has since been observed getting naturalised in shady places in the New Forest area. It was introduced as a garden plant in Ootacamund, South India. But now it has run wild there and is considered to be a serious pest in some places.

Erigero linifolius Willd. Sp. Pl. III (1804) 1255 (Compositae) F.B.I. III. 254.

Known from Africa, Australia etc., found as an escape in Punjab, U.P. & other places.

A herb, adpressedly grey strigose-hairy; stem erect, leafy, simple, the upper portion rarely branching, forming oblong-paniculate heads; lower leaves oblong-lanceolate, attenuated at the base, often sparsely denticulate, the others narrow-linear, sessile, acute; floral heads moderate in number, involucre dense and short, hairy; bracts sub-uniseriate narrow-linear, acuminate, somewhat strigosely hairy; female flowers many seriate, filiform, truncate; achenes sparsely hirsute, pappus reddish of 15-20 bristles in three rows.

Flowers and fruits rainy season.

Shillong, Khasi and Jaintia Hills, June 1943, N.L. Bor 17798.

Erigeron canadensis Linn. (Compositae) F.B.I. III. 254.

Known from Western Himalaya and the Punjab, ascending to 3,000 ft. All warm countries; assumed to be a native of North America.

Shillong, Khasi and Jaintia Hills, 4,700 ft. June 1943, N.L. Bor 17799.

A herb. The leaves of the plant are said to cause dermatitis.

Erigeron annuus (L.) Pers. Syn. ii 431. (Compositae).

Known from Mexico, Bermuda etc., Native of North America. It has also got naturalised in some of the hill stations in the United Provinces of India such as Mussoorie, Chakrata etc.

Annual, sparingly pubesecent with spreading hairs; stem erect, corymbosely branched. Leaves thin, the lower and the basal ones ovate or ovate-lanceolate, mostly obtuse, petioled, usually coarsely dentate, 5-15 cm. long, 2-65 cm. wide, the upper sessile or short-petioled, lanceolate, oblong or linear-lanceolate; heads rather numerous, 1-1.5 cm. broad; bracts somewhat hispid; rays 40-70, linear, white or commonly tinged with purple, 5-1 cm. long; pappus double, the inner a series of slender fragile deciduous bristles, often wanting in the ray-florets, the outer a persistent series of short, partly united, slender scales.

Shillong Peak, 5,400 ft., Khasi & Jaintia Hills, June, August and October 1943, N.L. Bor 17797, 17825, 17991.

"A herb. Flowers pale-mauve to very pale-blue."

Apparently escape from cultivation ?

Ambrosia artemisiaefolia Liwn. Sp. Pl. 988 (Compositae).

Widespread throughout North America, most common in the Eastern and North Central States.

Annual. Stems erect, much branched, rough-pubescent, 3-15 dm. high. Leaves mostly alternate, bipinnately parted, variable, nearly glabrous, thin, 5 10 cm. long. Heads unisexual; staminate heads in single or panicled racemes, near the top of the plant, 5-20 flowered, about 2 mm. in diam, with the involucre cup shaped, of 7-12 united bracts; pistillate heads axillary, sessile, 1-3 together, involucre obovoid, closed, becoming woody, resembling an achene and enclosing a single flower, and later a single achene; receptacle usually chaffy; disk flowers greenish white; ray-flowers wanting. Mature involucre 2-3 mm. long, top-shaped, with an apical beak surrounded by 5-10 tubercles, longitudinally ridged, pappus wanting.

Shillong, Khasi and Jaintia Hills 5,000 ft., October 1945 N.L. Bor 18428.

Probably an escape from cultivation.

A herbaceous shrub. It produces prolific quantities of wind-borne pollen, which is said to be the cause of most cases of late summer and autumnal hay fever.

Lactuca graciliflora DC. (Compositae) F.B.I. III. 406.

Known from Central and Eastern Himalaya, Nepal, Sikkim 6-12,000 ft.

Kegwema, Naga Hills, 5,000 ft., November 1945, N.L. Bor 20902.

A herb.

Campanumaea inflata C. B. Cl. (Campanulaceae) F.B I. III. 436.

Known from Sikkim and Bhotan 5-8,000 ft.

Naga Hills, 1935, N. L. Bor 6220.

Dzulake Valley, Naga Hills, 8,000 ft., September 1939, N.L. Bor-Dehra Dun Herbarium No. 90557.

Kohima, Naga Hills, 4,200 ft., July 1942, N.L. Bor 16272.

"A twiner with lurid, evil smelling flowers."

Agapetes hookeri (Cl) Sleumer Syn. *Pentapterygium hookeri* C.B. Cl. (Vacciniaceae) F.B.I. III. 450.

Known from Sikkim, 5-8,000 ft. and Bhotan.

Shillong, Peak 5,500 ft., Khasi and Jaintia Hills, July 1943, N.L. Bor 17880.

"An epiphyte, flowers crimson with a yellow band."

Sarcosperma kachinensis (King & Prain) Exell in Journ. Bot. LXIX (1931) 100 (Sapotaceae).

Reported from Upper Burma, near Simla, Kachin Hills.

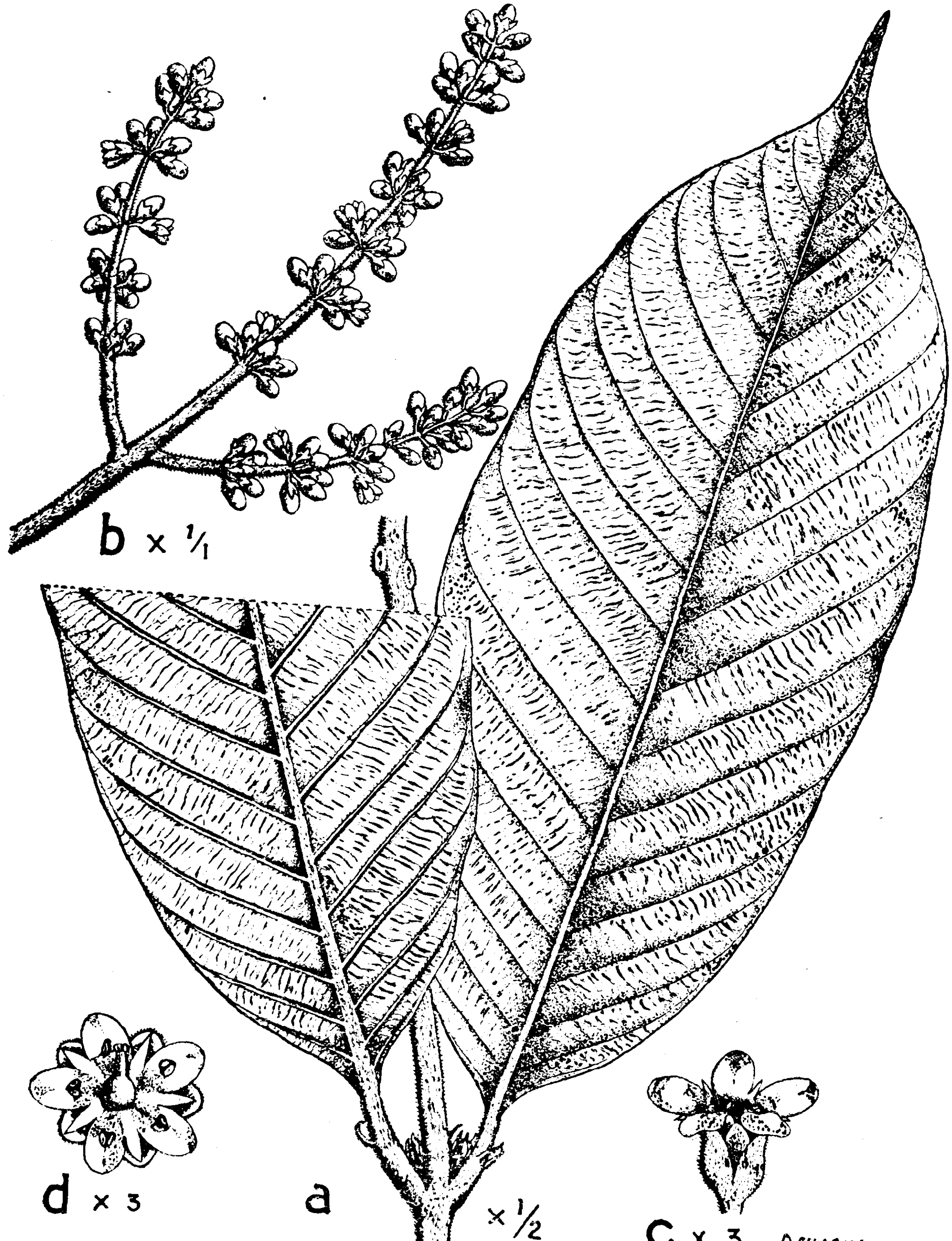
A small to medium-sized tree. Branchlets terete, tomentose. Leaves opposite or subopposite, oblong or ovate-oblong, 10-40 cm. long, 5-14.5 cm. wide, chartaceous, abruptly acuminate, apex caudate, base cuneate or almost round, margin entire, glabrous above except the midrib, which is somewhat pubesent, finely rusty-pubescent beneath, the nerves comparatively densely pubescent, pubescence ultimately disappearing; lateral nerves 10-14 pairs, prominent on the undersurfaces, faint on the upper surface; petiole flat, 1-2 cm. long, densely rusty-tomentose, near the junction of the lamina are two horn-like, subulate processes, about 2 mm. long; stipules linear subulate, 5-10 mm long, sub-persistent. Inflorescence axillary of simple or sparingly branched, almost spicate lax racemes, about 7 5-10 5 cm. long, densely rusty-tomentose. Flowers about 8 mm.-1 cm long, very shortly pedicelled, bracts ovate Calyx campanulate, 5-6 mm. long, densely rusty-tomentose outside, glabrous within, 5 lobed, lobes ovate acute, subequal, imbricate, 3 outer lobes thick, opaque, pilose and 2 inner comparatively thin with a some what scarious, hyaline, cilliolate margin. Corolla tube short, 5 lobed, lobes narrow obovate, somewhat valvate, exceeding the calyx, glabrous. Stamens 5, obtuse oblong, almost sessile, epipetalous, with 5 alternating, short subulate staminodes, anthers bi-lobed. Ovary sessile, ovoid, glabrous, unilocular with 2 ovules; style short, cylindric; stigma flat, indistinctly 5-toothed.

Deliungmukh, Lakhimpur District, February 1944, N. L. Bor 18047.

"A small to medium-sized tree with milky juice in true ever-green forest. Flowers yellowish."

This species has an interesting history behind it. It was originally described as *Combretum kachinense* from Kachin Hills, Burma by King and Prain in Jour. Asiatic.

PLATE 11



SARCOSPERMA KACHINENSIS (KING & PRAIN) EXELL

Soc. Beng. LXIX (1900) 169. Later, in April 1931, Exell transferred this species to *Sarcosperma*, proposing the new combination *Sarcosperma kachinensis* (King & Prain) Exell in Jour. Bot. LXIX (1931) 100. Still later, in October 1931, Cowan described a new species of *Sarcosperma* from Kachin Hills, Burma and named it *Sarcosperma kachinense* in Notes, Royal Bot. Garden Edinburgh, (Oct. 1931) 222. Cowan's description of his new species agrees in all details with that of *Sarcosperma kachinensis* (King & Prain) Exell. This fact coupled with the information about the distribution of the species leaves little doubt as to Cowan's species being conspecific with *Sarcosperma kachinensis* (K. & P.) Exell. We have therefore no hesitation in reducing *Sarcosperma kachinense* Cowan to the earlier published *S. kachinensis* (King & Prain) Exell.

Willughbeia tenuiflora Dyer (Apocynaceae) F.B.I. III. 625.

Known from Malacca. Cheswezumi, Naga Hills, 5,000 ft. July 1942, N. L. Bor 16185.

"A climber with milky juice, flowers white".

Ervatamia ophiorrhizoides (Kurz) Lace in List of Trees, Shrubs, Climbers, Burma, 91 (1912) Syn. *Tabernaemontana ophiorrhizoides* Kurz (Apocynaceae) F.B.I. III. 649.

Frequent in the hill forests of the Martaban hills, at 3000-5,000 ft.

Dibrugarh, Assam, May 1943, N. L. Bor 17783.

Pynursla, Khasi and Jaintia Hills, May 1943, N.L. Bor 17310.

"A shrub or a small tree, flowers white."

Gentiana capitata Ham. (Gentianaceae) F.B.I. IV. 113.

Known from Temperate Himalaya 4-12,000 ft., from Kumaon to Bhotan.

Shillong, peak 6,000 ft., Khasi and Jaintia Hills, January 1946, N.L. Bor 20895.

"Small herb, flowers blue to pale blue."

Strobilanthes rufescens T. And. (Acanthaceæ) F.B.I. IV 430.

Known from Pegu, Burma.

Peak 5,800 ft., Khasi and Jaintia Hills, November 1943, N.L. Bor 18068.

Ghaspani, Naga Hills 2,000 ft., March 1945, N L. Bor 18528.

A shrub, flowers white, tinged with purple; also blue, pale violet with purple patch.

Anisochilus carnosus Wall. (Labiateæ) F.B.I. IV 627.

Known from Kumaon and Garhwal ascending to 8,000 ft. and throughout Central and Southern India to Travancore and Ceylon. Upper Shillong 6,000 ft., August 1944, N.L. Bor 18101.

There is also an old collection by Jenkins from Assam in the Dehra Dun Herbarium.

"A tall herb with dark blood-red flowers".

Alternanthera paronychioides St. Hill. Voy. Bras. ii (1833) 439; Ind. For. Rec. (N. Ser.) Botany vol. I 5 (1939) 223 Syn. *Achyranthes polygonoides* (L.) Lamk. (Amarantacæ).

Native of Tropical America but now naturalised in several parts of India.

Okshungbung, 2,300 ft., Manipur State, March 1945, N.L. Bor 18536.

A prostrate, glabrous or sparingly pilose, branched herb.

Polygonum viviparum Linn. (Polygonaceæ) F.B.I. V. 31.

Known from alpine and subalpine Himalaya, from Kashmir to Sikkim, Western Tibbet 9-15,000 ft.

Laitlyngkot, 5,500 ft., Khasi and Jaintia Hills, April 1943, N.L. Bor 16085.

"A pink flowered Polygonum in marshes".

Chloranthus kachinensis King and Prain in Jour. As. Soc. Beng. Pt. II, Vol. LXIX, (1901) 173 (Chloranthaceæ).

Known from Kachin Hills, Burma.

Leaves subsessile, ovate, caudate — acuminate, margin finely gland — serrate except at the cuneate base, glabrous, shining above, dull and finely puberulous on the nerves beneath, 15-20 cm. long 7.5-9 cm. wide; caudate apex 2-2.5 cm. long; nerves about 10 pairs, doubly inarched within the margin of the leaf; petiole 5 mm. long or O. Spikes 9 cm. long, 4-6 together fascicled at the apex

of the branches among linear bracts surrounded by two closely approximated, distichous pairs of leaves ; anthers 3, connate by their connective.

Losami, Naga Hills, 5,000 ft., July 1942, N.L. Bor 16008.

An evergreen erect undershrub.

Euphorbia serrulata Reinw. ex. Bl. Bijdr. 635 (Euphorbiaceæ).

Known from Siam, Cambodia, Indo-China, Java, Malaya and China.

Annual herb. Roots slender, vertical. Stem erect, 15-60 cm. high, slender. glabrous. Leaves opposite, oblong or narrowly linear. apex-mucronate or sharp pointed, unequally cordate at the base or abruptly narrowing down at the petiole, size 1.55 cm. x 1·8 mm., the upper often longer, entire, finely denticulate except at the apex, absolutely glabrous; nerves basal 3-4, secondary nerves none; petiole 1-1·5 mm.; stipules triangular, fine. Inflorescence terminal or axillary at the apex, shortly peduncled, always dense, more or less few flowered, 3-8 mm. in length; bracts minute, encircling the flowers, pointed. Involucre campanulate, about 1 mm. in length, perianth lobes 5, triangular, ciliate, hairy within: glands 4-3, small with a petaloid appendix, suborbicular. Stamens 20-25, anthers orbicular 0.5 mm. long, cells dehiscing transversely, contiguous at the centre. Ovary superior, pedicelled, glabrous; styles 3, free, bifid or trifid, stigma not capitate. Fruit capsular, 2 mm. in diam., smooth, glabrous; seeds ovoid 1.2 mm. long, tetragonous, externally reticulate.

Plants very polymorphic in respect of the larger leaves.

Palel, 2,300 ft. Manipur State, July 1943, N.L. Bor 17975.

"A white flowered herb in swampy places."

This is the first record of this plant from our country.

Explanation of Fig. 1

a. Leafy twig, showing both serrate and entire leaves and axillary inflorescence with small bracts.

b. Flowers opened, showing calyx-tube with distantly placed teeth; stamens arranged in two series at the mouth of the calyx-tube and peltate stigma.

c. Fruits.

Explanation of Fig. 2

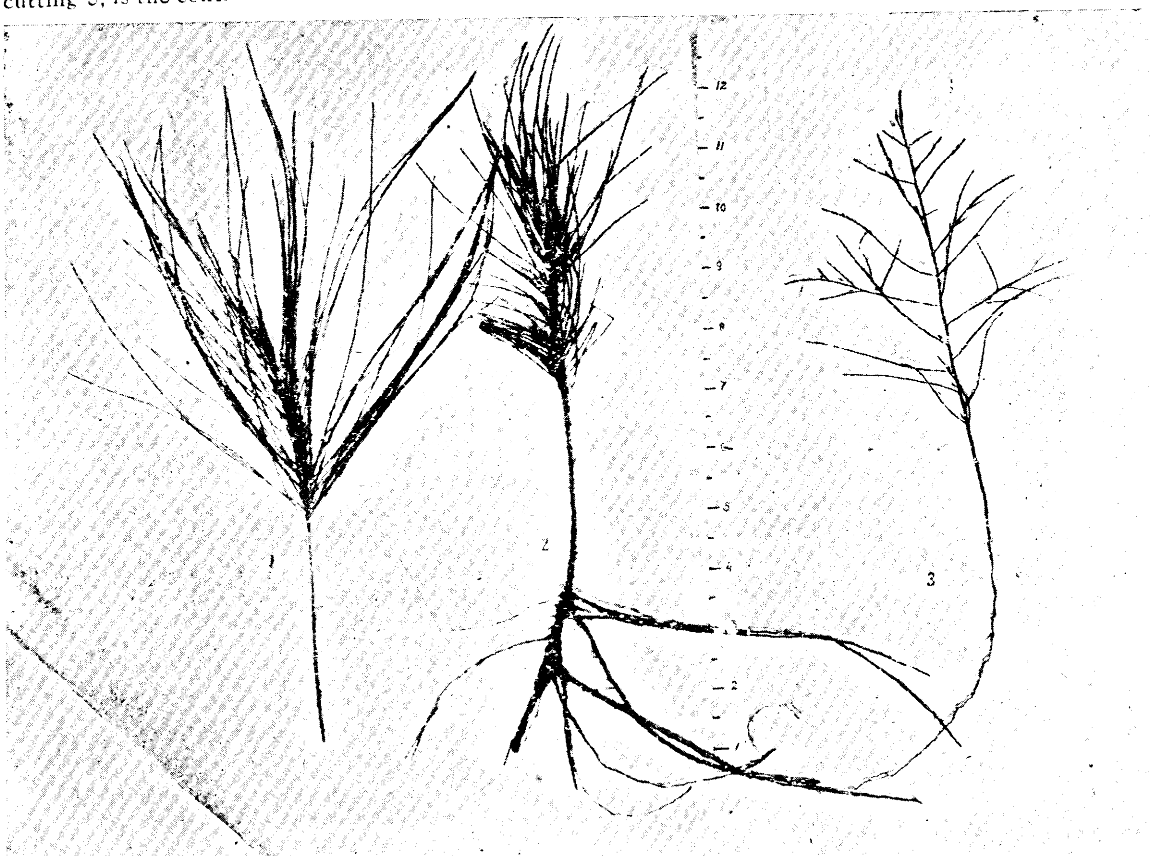
a. Leafy twing, petioles showing horn-like processes.

b. Inflorescence.

c. A single flower, showing imbricate calyx-lobes.

d. Flowers opened, showing almost sessile stamens with alternating staminodes in between the petals.

Propogation of *Cryptomeia japoniea* by branch cuttings in sand (3 months after planting)
1. Is the plant from branch cutting after treatment with seradix.
2, Is from branch cutting treated with seradix No.'3. 3. is control branch cutting, 4 is the branch cutting 3, is the control etc. etc. before planting 5 is the 4 months old seadling from seed sowing.



Propogation and Casuarina equisitifolia by branch cuttings in sand. (3 months after planting.)
1. The type and branches used. 2 strong and healthy root formation in the branch cuttings treated with seradix No. 3. No. 3 seedling from seed sowing 6 months old, tender and very weak

A short note on the propagation of CRYPTOMERIA JAPONICA and CASUARINA EQUISITIFOLIA by branch cutting

By S. N. Dabral.

Abstract. The note with his illustrations describes the possibility of propogation *Cryptomeria japonica* and *Casuarina equisitifolia* from their branch cuttings. Indications are that *Cryptomeria* can cut roots ever without application of any harmones

Apart from the expenditure in collecting seeds and raising nursery stock for plantations, the inevitable danger of high mortality of the weak and tender seedlings especially on grass lands could very much be minimised if vegetative propogation of plants could be successfully obtained from the branch cuttings. In attempting to induce the initiation of root-formation in branch cuttings of various species by the application of harmones, interesting results were obtained in the case of *Cryptomeria japonica* and *Casuarina equisitifolia*.

Cryptomeria japonica has extensively been introduced on the Darjeeling hills at elevations between 4000-6000 feet. At Dehra Dun, the germination has been recorded as low and never exceeded 30 percent, losing germination capacity within 40 days. The effect of harmone applied to the branches and even without it have given very encouraging results indicating the simplification of the method of its propogation. A short description of the method applied with the results is described below but the present indications need further trials for confirmation.

In addition to several other species, branches of *Cryptomeria japonica* 5" in length including the growth of the current year were cut down from the plants of about 8 years old on 23rd June 1948. Leaves at the base were trimmed off and he lower end of the freshly cut branches after being moistened were stirred, one lot in seradix No. 2 and the other in seradix No. 3. A third lot was kept as control. After tapping back the excess of the powder into the carton, the branches were all planted in sand keeping 2½" underneath it and were all given cover of thatch shelter. A day earlier, branches of *Cryptomeria* treated similarly as above were planted in standard soil composed of humus, sand and garden soil in equal proportion. By the end of September the branches of all other species were found to have died but that of *Cryptomeria japonica* and a few of *Casuarina equisetifolia* remained alive in sand although in standard soil all branches either had rotted or dried up. The results in term of the survival % are tabulated below :—

Species	Treatment			Medium used
	Seradix No 2	Seradix No. 3	Control	
Cryptomeria japonica.	80%	80%	100%	Sand
	Nil	Nil	4%	Standard
Casuarina equisetifolia.	Nil	40%	Nil	Sand
	Nil	Nil	Nil	Standard

After measuring the height growth of the plants a few plants were dug out and photographed for studying the root formation in them. The initiation of roots in the treated, untreated and the 5 months old seedlings from seed sowing is very apparent from the photographs Contrcl set of the *Cryptomeria japonica* branch crttings did not produce as many and as strong roots as the treated sets of which seradix No. 2 induced much more and healthier roots than seradix No. 3 which is suitable for a harder species than *Cryptomeria japonica.* There is better height growth in branches treated with the harmones than the height growth of the seedlings from sowings. Average height of the seedling was 1.5". The branches averaged to 2.9", 2.2" and 1.2" treated with seradix No. 2, No. 3 and control respectively.

Casuarina equisetifolia is particularly valuable for afforesting sandy areas and shifting sandy dunes. Its branches were obtained from trees about 17 years old and lower leaves upto about 3" were completely removed, leaving the upper branches a bit trimmed off. The naked portion of the branches were similarly treated and planted as that of the *Cryptomeria japonica* in sand as well as in the standard soil. The results by the end of September have been tabulated above indicating 40% of the branches to have developed roots in sand when treated with seradix No. 3.

The marked contrast in the root formation between the 6 months old seedling from seed sowing and that from the branch cuttings were very clearly seen after digging up the plants from the planting bed (See the photograph). The roots are more stout, spreading and somewhat bushy as against that of the seedling having long, thin and wiry roots with fine fibrous lateral roots.

The average growth of the seedling raised from sowings of age of 6 months is about 6.5" while as that from the branch cuttings is 4.6" but the latter are much stronger and would probably escape the damage which the natural seedlings are subjected to due to attacks of grubs, cricket, and other insects which cut through the stem and sometimes do very serious damage.

It was very interesting to note that the seedlings from branch cuttings could stand very rough handling. The specimen dug out from the nursery bed for the photographs happened to remain submerged in water for two days and were pressed between sheets of blotting papers to deprive them for excess of water before they were photographed. The seedlings remained in the laboratory without any care for about 12 hours after which they were incidentally replanted in the same bed. Seedlings raised from sowings faded and died in due course but the others from branch cuttings without any apparent set-back restarted putting on growth and cutting flush buddings of new leaves.

How far the plants propogated from branch cuttings would establish and develop has sttll to be watched but upto the end of the season, so far, these seedlings indicate promise of future prospects of their establishment. *Cryptrmeria japonica* plants are normally continuing to grew during the winter months also, but the growth is much more luxurient in cuttings treated with harmones than in control set, most probably due to lack of devolopment of strong root system in the latter as is apparent in the photographs, but no casualties have so far occured in any of the sets. ***Casurina equisetifolia*** branch cuttings are growing very vigorously. The information has also been collected incidentally that the seedlings from the branch cuttings could stand very rough handling in transplanting and when transplanted, it re-establishes itself without any set back. As it was a preliminary investigation, as said above, further trial is essential for confirmation and the result should be taken as indications of what may be expected.

Propogation of *Cryptomeria japonica* branch cuttings in sand (3 months after planting). No. 1 is the plant from cutting after treatment with seradix No. 2: No. 2 is from branch cutting treated with seradix No. 3; No. 3 is control branch cutting, No. 4 is the branch cutting before planting and No. 5 is the 4 months old seedling from seed sowing.

Propogation of *Casuarina equisetifolia* by branch cuttings in sand (3 months after planting). 1. The type of branches used; 2. Strong and healthy root formation in the branch cuttings treated with seradix No. 3; 3 Seedling from seed sowing 6 months old, tender and very weak.

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ANNUAL CONFERENCE OF FOREST RANGER'S ASSOCIATION C. P. AND BERAR

The 18th Annual Conference of C.P. and Berar, Forest Ranger's Associaton was held from the 13th to the 16th of September 1948. The session was inaugurated by Shri Lakhpat Rai, Chief Conservator of Forests C.P. and Berar in the University Convocation Hall. Before the work of this Association was commenced, a resolution expressing profound grief at the passing away of the "Father of the Nation" was read out by the Honorary Secretary, all standing; after which a 2 minutes silence was observed.

Shri Lakhpat Rai in his opening speech described the role that the forest played in ancient India to aid village economy. He pointed out that the forests were managed by kupadhyakshas (Conservator of Forests) and Gowardhan Puja was introduced by Lord Krishna to educate the people in respect of protection of forests, which are a source of water supply which is the source of all life. In the end he impressed on the members of the Association the need to serve loyally like forests which serve humanity without expecting any reward.

Shri Kanta Prasad Sagreiya. Secretary Forest Policy Committee, C.P. and Berar gave a talk in Hindi on "Forests and Public Welfare" (जंगल और जनहित) in which he traced the origin of scientific forestry to the practice of the *Dahya* method of shifting cultivation under which forests were felled and burnt to obtain fertile soil for raising field crops. When such practices eventually resulted in a serious deficiency of fuel and other essential requirements of the people and also adversely effected agricultural practice through soil-losses man turned his thoughts to soil conservation, silviculture and afforestation. This is how out of sheer necessity the science of forestry was born. He narrated the direct and indirect benefits that forests confer on the people and particularly the role that they play in sustaining agriculture and therefore he argued that forestry is not the "hand-maid" of agriculture as some have called it but actually its "foster mother" without which agriculture will become impossible owing to loss of soil moisture and denudation. He therefore urged that the "Grow More Food Campaign" should instead of concentrating on the extension of cultivation on marginal lands, devote greater attention to production of more fuel to release cow-dung for manurial purposes, and on conservation of agricultural soils by proper anti-erosion measure. Finally, he quoted the Taittiriya Upanishad and the Bhagwadgita to show that these recommendations are nothing new. The preceptor in the Upanishad advised his students to resolve to grow More Food, (अन्नं बहु कुर्वीत) The Bhagwadgita has also given a vivid account in Chapter III, verses 13 et. seq. of the natural cycle of forest conservation, and constant efforts which alone can result in improving soil-moisture and thus helping agriculture.

Lala Arjun Singh, M.L.A. a Member of the Forest Policy Committee next addressed the meeting. In his usual interesting and witty talk, he impressed on the audience the benefit of forests and advised the members to carry their message to the masses.

Swami Krishanand, M.L.A. of Saugor emphasised the need for selfless public service.

In the end Shri Bhawani Shankar Niyogi, Member, Public Service Commission, C.P. and Berar pointed out the inter-relation between forests and agriculture. He advised the members of the Association not to indulge in politics or to make too many complaints regarding their prospects, but serve the country and its people in this hour of trial unmindful of self. The popular Government cannot fail to realise the importance that the forest wealth of the country plays in promoting

the well being of the people and therefore the members of the Association may rest assured that they will see that those who are entrusted with the custody of this natural asset are given their due.

H.P. VARMA,
HONORARY SECRETARY,
Forest Ranger's Association.

RESOLUTIONS PASSED BY THE C.P. & BERAR FOREST RANGERS ASSOCIATION, 1948-49 SESSION

Held at Nagpur on 15th to 16th September, 1948.

I. C.P. and Berar Forest Rangers' Association places on record the deep sense of grief on the sudden demise, on 30th June 1948, of the architect of Independence of India, non-violence personified, Father of Indian Nation, Saint and a great soul, late Bapu, and prays the Almighty to bless the departed soul with ever lasting peace. May his life and teachings be guide for us, to take us to the path of truth and non-violence.

II. C.P. and Berar Forest Rangers' Association expresses grief on the premature passing away of late retired Forest Ranger Harcharansingh. May his soul rest in peace. The Association further conveys its heartfelt condolence to the bereaved family and dependents and prays God to grant them strength to withstand his absence.

III This Association takes a note of the order of the Government to Resolution No. IX of 1946, in respect of maintenance of character roll of Rangers by the Conservator in as much as rejecting the requests of the Association

This Association still feels the necessity of requesting the Government for reconsideration of the orders in view of para 1 of the Government's Memo No. 414/95/XI, dated 28th February 1948 where due importance is given to character roll remarks which are not agreed to by the Government to be substituted with any kind of competitive test or examination.

The main object of the petition of the Association is to request the Government to protect the permanent record of service personel from being effected by temporary annoyance of their officers with whom they directly come in contact oft and on in various respects. In many cases, opinions have changed in course of time but record could not be reversed in view of the remark already made. If the rolls are kept with the Conservator of Forests, the officers will have chance to reconsider and in all probability change their opinion.

Lastly, as the Conservator of Forests is the appointing and the punishing authority, the rolls are invariably expected to be kept with him, who will look into the remarks proposed to be entered by the Divisional Forest Officer and see if justice has been don and provisions of the Book Circular have been duly carried out.

IV. The Association reads with great disappointment the reply of the Government, rejecting its demand for a free grant of timber to each member for construction of a house to enable him to build a small dwelling place to pass his retired life with peace and comfort.

In view of the acute housing problem and incapabilities of the service personel to build a house for themselves and difficulty of availability of houses on rent after they leave the Government quarters, the Association is compelled by force of circumstances to approach the Government to reconsider their decision.

V. To the reply of the Government to Resolution No. XVI of 1946, the Association appreciates the decision taken by the Government in respect of promotions, and further requests the Government to reserve 50% of cadre of superior service to be filled in by promoting Rangers.

VI. In view of the reply of the Government in respect of occupation of Forest Rest Houses, this Association requests the Chief Conservator of Forests to issue a circular to the Divisional Forest Officers to permit the Forest Rangers when on duty, to occupy the Forest Rest Houses.

VII. This Association has read the reply of Government, considering it unnecessary to provide a Chowkidar for each Range quarter. It is hereby respectfully reques ed by the Association that the Government safe which is generally fixed in the bed room of the Range Officer be ordered to be removed to the Range Office room in the interest of protection of his family members who have to sleep in that bed room in absence of the Range Officer himself for over 20 days in a month.

VIII. This Association submits for perusal of the Government, copy of para 13 of the request made by the Executive Committee of this Association to the Provincial Pay Committee, in respect of reducing the heavy work for which a Range Officer is held responsible and arrest the further increase of the same by reducing the size of Ranges from 125 to 80 sq. miles according to the feasibility of management.

In view of this fact, the Divisional Forest Officers had been directed to submit proposals for redistributing the charges of Ranges but it seems, the proposal has not finalised as yet. This Association requests that the matter be speeded and relief rendered to the members of this service who are over worked at present and suffering the results of ever increasing responsibilities.

Copy of para 13

"The charges of many of the Ranges are very heavy and unweidly in this province and Rangers in such ranges have invariably come to grief in respect of the management of such ranges. According to the postwar development plan by Mr. V.K. Maitland, I.F.S., the number of divisions have been proposed to be increased from 18 to 28 with a view of reducing the charge of forest division to 700 sq. miles and increasing the territorial Conservators from 3 to 4. (N.B.—This is before Chhattiagarh Merging) but it is unfortunate that charges of Rangers have remained the same. Several new schemes, such as, construction of roads and bridges, housing of subordinates, grazing service, water supply, improvement of fodder, lac propagation, welfare of forest population including publicity and education have been proposed. All these schemes are bound to create heavy rush of work in respect of maintenance of accounts and statistical record, besides heavy correspondence. Inspite of extra staff provided therein, the Range Officers' responsibility will be there, for all the works in his range. Hence ranges be reduced to workable minimum i.e from 80 to 125 sq. miles in area according to the feasibility of management. Further, it is also requested that officers appointed in charge of special works, be appointed as disbursers and should maintain their own accounts. However the same may be incorporated in range accounts".

IX. This Association brings to the notice of the Government the fact that arms which are so essential for the efficiency of this service for the protection of the life of service personel and property of the Government, are rarely available in the market, and, more so, the cost has risen to such an extent that it is beyond the means of service personels to purchase the same.

An enquiry in respect of supply of arms to the subordinates of Forest Department was made sometime past but the matters have remained undecided.

This Association respectfully requests the Government to make guns and rifles available to this service, or supply be arranged through Government agency, as soon as possible.

XX. The Chief Conservator of Forests is requested to restart the publication of the Classified list of Forest Rangers which seem to have been discontinued since 1945, in order to inform the members of their position in the list.

It is also further requested that the list be made available to the members on payment.

(N.B.—As the list for 1948 has been published since the later part of the resolution is requested to be given effect to).

AMERICAN FORESTRY PROFESSION ADOPTS CODE OF ETHICS

A code of ethics for the forestry profession was adopted in November by the Society of American Foresters. The members voted by letter ballot.

The code was developed by a special committee of the Society which made a study of the ethical practices of older professional groups. The newly adopted canons will be broadly construed in the interest of the public welfare and professional advancement. They are now deemed to be duties, obligations, and responsibilities of the technical forester to all those with whom he comes into contact in the course of his professional work and life.

The Society of American Foresters, organized in 1900 in Washington, D. C. has a membership of 6,000, in the United States and Canada. Its official organ is the JOURNAL OF FORESTRY.

Code of Ethics for the Profession of Forestry

The purpose of these canons is to formulate guiding principles of professional conduct for foresters in their relations with each other, with their employers, and with the public. The observance of these canons secures decent and honorable professional and human relationships, establishes enduring mutual confidence and respect, and enables the profession to give its maximum service.

Professional Life

1. The professional forester will utilize his knowledge and skill for the benefit of society. He will cooperate in extending the effectiveness of the forestry profession by interchanging information and experience with other foresters, and by contributing to the work of forestry societies, associations, schools, and publication.

2. He will advertise only in a dignified manner, setting forth in truthful and factual statements the services he is prepared to render for his prospective clients and for the public.

Relations with the Public

3. He will strive for correct and increasing knowledge of forestry and the dissemination of this knowledge, and will discharge and condemn the spreading of untrue unfair, and exaggerated statements concerning forestry.

4. He will not issue statements, criticism, or arguments on matters connected with public forestry policies, without indicating, at the same time, on whose behalf he is acting.

5. When serving as an expert witness on forestry matters, in a public or private fact finding proceeding, he will base his testimony on adequate knowledge of the subject matter, and render his opinion on his own honest convictions.

6. He will refrain from expressing publicly an opinion on a technical subject unless he is informed as to the facts relating thereto, and will not distort or with-hold data of a substantial or other nature for the purpose of substantiating a point of view.

Relations with Clients, Principals, and Employers

7. He will be loyal to his client or to the organization in which he is employed and will faithfully perform his work and assignments.

8. He will present clearly the consequences to be expected from deviations proposed if his professional forestry judgment is overruled by nontechnical authority in cases where he is responsible for the technical adequacy of forestry or related work.

9. He will not voluntarily disclose information concerning the business affairs of his emplayers, principals or clients, which they desire to keep confidential, unless express permission is first obtained.

10. He will not, without the full knowledge and consent of his client or employer, have an interest in any business which may influence his judgment in regard to the work for which he is engaged.

11. He will not, for the same service, accept compensation of any kind, other than from his client, principal, or employer, without full disclosure, knowledge, and consent of all parties concerned.

12. He will engage, or advise his client or employer to engage, other experts and specialists in forestry and related fields whenever the client's or employer's interests would be best served by such actions, and will cooperate freely with them in their work.

Relations with Professional Foresters

13. He will at all times strive to protect the forestry profession collectively and individually from misrepresentation and misunderstanding.

14. He will aid in safeguarding the profession against the admission to its ranks of persons unqualified because of lack of good moral character or of adequate training.

15. In writing or in speech he will be scrupulous to give full credit to others in so far as his knowledge goes, for procedures and methods devised or discovered and ideas advanced or aid given.

16. He will not intentionally and without just cause, directly or indirectly, injure the reputation or business of another forester.

17. If he has substantial and convincing evidence of unprofessional conduct of a forester, he will present the information to the proper authority for action.

18. He will not compete with another on the basis of charges for work by underbidding through reduction of his quoted fee after being informed of the fee quoted by a competitor.

19. He will not use the advantages of a

salaried position to compete unfairly with another forester.

20. He will not attempt to supplant another forester in a particular employment, after becoming aware that the latter has been definitely engaged.

21. He will not review the work of another forester, for the latter's employer without the other's knowledge, unless the latter's connection with the work has been terminated.

22. He will base all letters of reference or oral recommendation on a fair and unbiased evaluation of the party concerned.

23. To the best of his ability he will support, work for, and adhere to the principles of the merit system of employment.

24. He will not participate in soliciting or collecting financial contributions from subordinates or employees for political purposes.

25. He will uphold the principle of appropriate and adequate compensation for those engaged in forestry work, including those in subordinate positions, as being in the public interest and maintaining the standards of the profession.

CONTOUR TILLAGE AND TERRACING

By

P. V. C. Rao, Graduate, I.E.E., M.I.E.T. (London.)

Corporate Member of the American Society of Agricultural Engineers.

When we cultivate up and down the slopes as the majority of our cultivators do at present, we shall be aiding the rapid erosion of the slopes. When the rain beats the soil and digs it out, the debris so collected is carried by the rushing water through the innumerable furrows down to the valley streams. The rich top soil of the land is thus rapidly lost and the unproductive subsoil is exposed. This kind of phenomenon is far more potent when row crops are planted up and down the slope. If any fertilizer is used with a view to increasing the fertility of the land, it is also washed away by the rushing streams. Thus the loss is cummulative in effect-the loss of the soil and also the loss of the fertilizer.

The rate of such water erosion depends upon the degree of the slope, the condition of the land and the general cultural practices in usage. Erosion begins first by the peeling off of the top soil by the slow invidious process of what is known as sheet erosion. It is more menacing and deceptive as the cream of top soil slowly vanishes without the farmer noticing the phenomenon. Most of our fields have been the victims of sheet erosion and are gradually losing their productivity.

The fan-wise rills grow deeper and deeper into wider gullies at points of greater susceptibility. Gullies increase the pace of erosion and render the field gradually unsuitable for cultivation. Gully erosion is the final phase for relegating the fields to a fallow state.

When the field is tilled and left unprotected during summer, the soil is swept off by wind. The dust storms and the sand dunes are generally formed by this kind of erosional debris. Wind erosion is yet another process through which the invaluable top soil of our fields, especially those in the dry districts, is being swept away.

The evil effects of soil erosion are manifold. The fields lose their fertility, the barren slopes generate floods that engulf vast stretches of rural and urban areas, and the soil that should produce rich food, is carried by the floods in the form of sedimentation to fill up the reservoir bed and the channels or to choke the sluice valves and harbour mouths. When it is swept by wind, it clogs the house and tree tops, blinds the pedestrians and spoil the ecstasy of the surroundings.

We clamour for costly fertilizers, but we forget for a moment that the fertilizer can at best add to the strength of the soil, but cannot create the soil itself. No ornamentation is ever possible on a mutilated body or a dilapidated building. What is more when the soil itself is unprotected and is left to the vagaries of the wind and water, how can we protect the fertilizer from being washed away? The soil as well as the fertilizer is lost:

We should devise ways and means for arresting this colossal loss through soil erosion. The technique employed is varied according to the topography, rainfall, type of soil and degree of erosion of the land. The general methods are contour terracing, contour cultivation, contour trenching, afforestation, strip cropping, rotation and multch farming.

Cultivated and cultivable slopes not exceeding 10 percent in gradient are contour bunded with what are known as terraces or major bunds. In places like the Ceded Districts and the Bombay Carnatic where the rainfall does not exceed 25 inches and it is essential to conserve every drop of the rain, the bund is constructed on strict contour without any spill ways. On certain types of soils, the American type of broad based terraces will be effective. Where the rainfall exceeds 50 inches, the the drainage type of terrace with dropping contour and with spill ways at the tail end are suitable. The drainage water is led through sodded channels at nonerosive velocities.

The fields in between the bunds or terraces are contour-furrowed, so that each furrow will act as a miniature bund and assists the major bunds in holding and helping the absorption of all the rain water. The furrows also protect the bunds from breaching at off-the-contour pockets. Where mechanical power is employed for cultivation, the contour furrow running across the slopes will effect considerable savings in the fuel consumption and also in the wear and tear of the machine. The contour furrow holds the fertilizer from washing.

Contour strip cropping is a method of cultivating alternative strips of erosion and non-erosion type of crops on the contour in strips of 40 to 50 feet wide. The row crops such as corn and cotton are alternated by close growing crops of soil building variety. Water and soil washed from the upper strip of row crop are held up by the lower strip of close growing crop. Strip cropping on the contour augments the yields considerably.

Rotation of crops preserves the fertility of the soil and increases the yield of the crops. The soil depleting crops such as cotton, tobacco and oil seeds are followed by leguminous crops. When some of the leguminous crops are ploughed in as farm mulch, and the artificial fertilizer is applied for the farm mulch instead of for the main crop and when such mulch is mixed with the soil, there will be definite increase in the crop yields and also the balance of fertility of the field is maintained at a high level.

Slopes exceeding 10 percent in gradient and also the uncultivable wastes are contour trenched and afforested. When these forests grow, they help the contour fields below in innumerable ways. Soil erosion began with the depletion of the forests, and the manifold evils of drifting droughts and floods are all the legacies of the ruinous policy of denudation. It is highly essential that the lost forests are rapidly rebuilt for the sake of our agriculture, climate and rainfall.

The ideal method of carrying out these operations is on a mass scale without any regard to the ownership of the land. The only limiting line is a contour. If in any case the fragmented holdings leave loopholes in the corners, a realignment of strips by mutual exchange of plots will become necessary. The Bombay Land Improvement Act envisages the utility of the contour bunds as delimiting field boundaries. Consolidation of holdings is no doubt an ideal method of overcoming the difficulties arising out of irregular field boundaries; nevertheless, land reform should never delay the reform on the land.

AFTER RIPENING IN *JUNIPERUS MACROPODA*

By S. N. DABRAL, F.R.I.

Abstract: ***Juniperus macropoda*** **Seeds ordinarily do not give more than 1 per cent germination. The dormancy is due to after-ripening required: 2 years old seed collected in December and stored under ground for 2-3 months has given upto 20 per cent germination. Treated seeds enter into a secondary dormancy after about 30 days of sowing.**

Juniperus macropoda is a species of the inner Himalayas from Nepal westwards growing more or less gregariously on arid tracts between 5,000—14,000 feet elevation. In Baluchistan, the species is abundant and is of considerable economic value. Some 30 years back, Troup described it to be growing gregariously in open or in scattered patches over an area of 1,500 square miles. The wood is considered first class for pencil making, standing equal to the American pencil cedar.

The present condition of the juniper forests in Baluchistan is deplorable. Heavy over-grazing, denudation and consequent erosion have made the forests very open and largely consisting of old trees. The Juniper seeds fairly well every year and yet there is practically no regeneration in Mazhar and Ziarat forests though occasional seedlings are seen under trailing branches of the old trees in North Zarghun. Griffith (1946) commented that the conditions have much changed and it

is now too late to perpetuate the natural type but patches still could persist on favourable sites.

As natural regeneration is negligible, attempts are made to artificially regenerate the species but little is known by the local foresters about the time of collection, age of seed for best germination and the method for germinating the seeds. The local belief is that 2nd year berries give the best germination, which in any case hardly exceeds 1 percent. Finding artificial germination an impracticable proposition, the local officers attempted raising plantation by transplanting natural seedlings, but the survivals were few. So it was decided to carry out investigations on seed collected monthly from 1st, 2nd and 3rd year berries.

Seeds were mostly received from North Zarghun of which climatic statistics are little known and where juniper has been reported to be growing reasonably well. The first lot of seed was collected in August, 1945 and sent to us followed by subsequent lots of monthly collection with occasional breaks. The seeds when received were first weighed and a portion subjected to cutting test to determine the soundness percent. Soundness percent in 1, 2 and 3 year old seeds from the last collection received was found to be 4, 36 and 40 percent respectively. The result of seed weighment is produced below in number of seeds to an ounce.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1st year ...	1936	2012	1240	...	...	1652	1120	1642	1248	1239	1760	1570
2nd year ...	752	596	1025	828	826	888	832	600	780	681	751	751
3rd year ...	6.0	622	654	700	888	579	776	650	693	787	782	759

In collection of preliminary data, one lot from each month's collection was sown without any treatment in pots filled with garden soil, sand and leaf mould well mixed in equal proportion and kept under thatched shade. The germination obtained confirms the disappointment and is produced below :—

Month of collection	1st year nursery		2nd year nursery		3rd year nursery		Period of germination in days
	Number of seeds sown	Germination %	Number of seeds sown	Germination %	Number of seeds sown	Germination %	
August ...	300	Nil	500	1.8	500	0.8	360
September ...	...	...	500	0.4	500	Nil	316
October ...	...	...	250	Nil	250	0.4	382
November ...	300	Nil	400	Nil	500	Nil	310
December ...	500	Nil	500	Nil	500	Nil	314
January ...	...	...	...	...	...	...	...
February ...	...	...	...	...	...	...	...
March ...	...	...	500	Nil	100	Nil	229
April ...	...	...	500	Nil	500	0.2	263
May ...	...	...	500	Nil	500	Nil	154

The observation continued till all the seeds sown had rotted in the soil. In some of the seeds it appeared that germination process had set in but the hypocotyl was strangulated within the hard seed-coat, which suggested trying some pre-sowing treatment for improvement in germination. The treatments applied and results obtained are given below :—

Pre-sowing treatments	Germination percent					
	1st year berries		2nd year berries		3rd year berries	
	Treated	Control	Treated	Control	Treated	Control
Soaked in cold water for 24 hours (each lot having at least 100 seeds).	Nil	Nil	Nil	Nil	0.5	Nil
	Nil	Nil	Nil	Nil	0.7	Nil
	Nil	Nil	Nil	Nil	0.3	Nil
Soaked in cold water for 48 hours each (lot having at least 100 seeds).	Nil	Nil	Nil	Nil	0.3	Nil
	Nil	Nil	Nil	Nil	0.7	...
	0.5	Nil	...	...	2.0	...
Soaked in soda lye for 20 minutes washed and sown in river sand (each lot having at least 100 seeds).	...	...	Nil	Nil	Nil	Nil
	...	...	Nil	Nil	Nil	Nil
Kept in oven at 21° C for 24 hours (each lot of 50 seeds).	...	...	2.0†	Nil	Nil	Nil
	...	...	Nil	0.5	Nil	Nil
	...	...	Nil	Nil	Nil	Nil
	...	...	...	...	Nil	Nil
Soaked in commercial sulphuric acid for each lot of 50 seeds: 15 minutes	...	...	Nil	...	Nil	...
30 minutes	...	...	Nil	...	Nil	...
45 minutes	...	...	Nil	...	Nil	...
60 minutes	...	...	Nil	...	Nil	...
90 minutes	...	...	2.0*	...	Nil	...
120 minutes	...	...	Nil	...	Nil	...
Soaked in boiled water ...	Nil	Nil	Nil	1.0	0.5	Nil
	Nil	Nil	Nil	Nil	Nil	Nil
	Nil	Nil	Nil	2.0	Nil	0.3
	...	...	Nil	Nil	Nil	0.3

None of the above treatments gave consistent and encouraging results. It appeared that the dormancy is due neither to the seed-coat effect nor due to rudimentary embryo. The possibility left out is of the dormant embryo requiring after-ripening treatment.

Young (1919) in his investigation with yellow poplar seeds obtained only 487 seedlings from 2 lbs. of seeds sown in fall. The same quantity stratified in moist sand and buried in a sandy soil in November and sown in May, gave 1088 seedlings against 8 seedlings obtained from the control stored during the period in a cloth sack and sown in May.

Pack (1921) found germination of non-ripened seed to be very low and treatment with sulphuric acid etc. to be in effective. freezing and thawing has no action in shortening this process and neither the resting nor after ripened seeds gave good germination at temperature over 15° C. He found that after-ripening occurs best at 5° C and is quicker in con-

• Germination after 195 days.
• Germination after 259 days.

junction with darkness and descication. Perhaps secondary dormancy sets in when after-ripened seed is transferred to higher temperature as then it gives lower germination than if left at 5° C.

Baldwin (1942) records that after-ripening of dormant embryo proceeds best at temperature lower than those usually best for germination and to meet this requirement, stratification is commonly and successfully employed in forestry.

Dealing with *Juniperus macropoda* it was thought better to try a method that could successfully be carried out in a remote forest The seeds were soaked in cold water for 24 hours and then buried in garden soil 2 ft. deep in a glass bottle. The pit was near a water tap and remained always shaded. The seeds used were collected in December 1947 and were put into the pit on 3rd January 1948. Germination obtained from them taken out of the pit at intervals are given below :—

		Germination obtained		
Duration of storage in pits in days	Number of seeds sown in each lot	1st year berry	2nd year berry	3rd year berry
30	100	2%	3%	3%
60	100	10%	20%	6%
91	50	4%	16%	4%
120	50	Nil	2%	Nil
244	...	1 out of 7	6 out of 70 seeds	Nil out of 30 seeds

It was noticed that germination period of the treated seeds was over after about 30 days of sowing after which a secondary dormancy sets in.

Pack found 100 days storage as best. Here also very encouraging germination has been obtained after 60-90 days storage. It is also noticed that seedlings obtained from these treated seeds are much healthier than those from the untreated ones.

Dehra Dun is perhaps climatically unsuitable for the species. A higher germination percentage is expected from seeds tried in its natural habitat. Thinking in terms of the climatic conditions in juniper forests, perhaps, better results would be obtained from 2 years old seeds collected at the beginning of winter and stored in pit till May next.

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FROM SCRUB-FORESTS TO SHRUB-FORESTS OF BIJAPUR DISTRICT AND THE PROBLEM OF AFFORESTATION

S. T. BANASODE, B.A.,
R. F. O. Bagalkot.

Bijapur is a notorious famine District; for a long period in the past it has also been under the sway of the negation of famine Act. Its population is $9\frac{3}{4}$ lakhs. Taking into account all the Government investments to safeguard the public against the famine during the last regime, it would be a huge amount sufficient probably to convert the present hell into heaven under the modern multi-purpose schemes of the Damodhar valley type. Yet it has five rich valleys spreading along the five perennial rivers: Bhima, Don, Krishna, Ghataprabha and Malaprabha and all of them having rich black cotton soil. They are irrigable tracts with some device lift irrigation, well irrigation or by canal system, even with inter-Dis trict or States management. It is the driest part of the Bombay Province still having a good number of perennial rivers passing through. It is an irony of fate for the riverside people on either bank to suffer the heaviest drought, carrying water for miles during major part of the year. If this be the state of men and animals, imagine that of land and tree-stock. Lives that can move may drag on up and down to keep up bone and skin together. But lives that are static in the form of vegetative growth are pitifully born and die-back annually in situ. Out of this life's turmoil in the vegetable-kingdom, a few

hardy species stand and stare at the burning summer awaiting stray monsoon rains to quench their thirst and to put on some fresh leaves and wood, bit by bit and year after year, termed as Scrub-Forests.

It is this type of slim tree-growth on rocky hill ranges—that constitute the Scrub-Forests of the Bijapur Dist. You need an umbrella to keep your head cool under the scorching Sun, as you walk through these sparcely wooded areas. The Forest area of the District under the control of the Forest Department is only 4.5 percent very much unevenly distributed in Sourthern Division, while there is no forest area at all in the Northern Division, where people entirely use cowdung cakes, corn and cotton stubbles in place of firewood. Much of the valuable farm-yard manure is lost to the cultivator for want of fuel and fodder reserves in the District.

Today the demand on firewood has abnormally increased. Originally the hearth used to burn for an hour or so in the morning and evening. Owing to the habitat of tea taking very often, the period must now have definitely increased three to four times. While formerly there were no tea shops in villages, you will now find several. Firewood consuming centres have multiplied abnormally, whereas the rate of firewood production is getting less in the increasing arid conditions nowadays.

It was, therefore, a matter of vital importance for the prosperity of posterity that the conservation of the existing forests should have been on stricter lines and afforestation on a large scale should have been undertaken long before, feeling the pulse of Nature's balance. However, the oft repeated failure of crops in the Deccan, arrested the attention of the Bombay Govt. and forced them to make a determined effort to solve the problem. Early in 1942 the Land Improvement Scheme was enacted and the activities of the Agricultural and the Forest Departments were encouraged. Although nothing short of the Tennessy Valley type scheme would ameliorate the land and the people, the interim measures of large scale bunding, contour trenching and afforestation by catchment areas were undertaken through the Agricultural Department. The Forest Department adopted a slow and steady policy of experimentation and demonstration, on the question of reboisement of waste lands and arid areas of the present reserve forests in its charge.

The sample plots in representative forest areas and 'Gairans' may be broadly classified under the following categories. And they are the arid area research centres of pioneer nature in this tract :—

(1) Plots of simple closure in both of treated and untreated lands ;

(2) Plots of contour-trenching and planting in various soils, slopes and aspects ;

(3) Plots on flat ground sown in lines or spacings of 6'x6' or 20 feet width ;

(4) Plots of pure grasslands without closure.

Rainfall conditions for all these are common with an average of about 15" annually occurring uneven and sporadic in nature, usually between June and September with stray winter showers. My observation in all these cases is as under:—

(1) There is decidedly a quantitative increase in the yield of grass from three to eight times, with a good proportion of natural regeneration appearing in the treated land with -contour-trenching. "Nature rebuilds itself even under adverse conditions" is amply proved.

(2) plots under this category are of immense interest. Herein the active process of ecological change for the better is set in. Every year there is floral change. Anti-erosion measures of both mechanical and vegetative methods play their part to the best advantage. The mechanical measure is based on the principle of contouring. Trenches of 2' x 1½' section along the contour line would be just sufficient to arrest the sweeping flow of water during precipitations. The dug-out loose earth is utilised to refill the trenches diagonally on the lower side, so as to serve as seedbeds for tree plants. Now, as to the spacing of two contour lines, lower the rainfall the wider will be the spacing, varying from 75' to 200' according to its gradient. In addition to these trenches deep gulleys are plugged with dry stones to cut down the speed of rain water. For the vegetative changes ecological study is done and the local species—which have already survived are used. For nothing succeeds like success. Locally *neem*, *siras* and *jaman* is plentiful and the same is used. *anjan*, common in similar tracts of Khandesh and Dharwar Districts, is also used with great advantage and all of them are thriving. Even in the midst of summer, it was a sight to see at Tulsigeri sample plot, the rich coppery red

leaves of *anjan*, the shimmering foliage of Saman and—the yellowish light-green fresh leaves of *neem* and *siras*, against the background of the dry thorny scrub-forest in extant. Similar demonstration plots at Hippárgi in Sindgi taluka and Injinwari in Badami taluka stand in evidence of the fulfilment of the object aimed at.

(3). Under this category observations though out the present forest areas of natural and artificial regeneration may be made. The present system of working the forest areas is clear felling with reservation of standards. In the clear felled coupe annually one thousand pits of 1′ x 1′ x 1′ size at 6′ x 6′ spacing are dug out and dibbled with local species. This is the practice in v gue from the beginning of the working plan operation: but—curiously enough no plantations have been successful by this pit system of planting in this region, excepting moist localities. Probably the system is unsuited and needs to be replaced by the contour-trenching and afforestation with gully-plugging etc. on popular lines.

(4) As to the purely grass plots, no special efforts for reseeding with improved seeds has been done in this District and as such nothing definite can be said. However from the experience gained elsewhere reseeding of hill-ranges can safely be undertaken by contour plowing and ridging if necessary at intervals, to hold the rainwater in the soil.

In support of the results it may be stated from the forest records of Tulsigeri sample plot, the plant heights and the volume of vegetative growth during the past five years, together with the general improvement of natural regeneration are very encouraging, which may be seen from the following table:—

Species	No of plants	Maximum Ht. in 3rd yr.	Maximum Ht. in 4th yr.	Maximum Ht. in 5th yr.	Remarks
Neem ...	390	7'	8'	10'—6″	Plot is laid out in c. 17 of Bl. VIII of Bijapur Scrub-Forests
Siras ...	852	8'	12'—6″	14'—6″	
Anjan ...	200	5'	5'—7″	6'—7″	
Kasod ...	377	10'	12'—4″	15'—3″	
Sandal ...	10	5'	9'—5″	15'—0″	
Chinch ...	481	3'—6″	3'—11″	6—11	

With a total of 2, 310 plants in the plot of A. G. 9-2 the per acre stocking comes to 257 plants at present in the 5th year and after 10th year there are bound to be at least 100 trees per acre if not more.

Cost involved. The major item of expenditure is the cost of trenching and the protective staff at least for five years. That of trenching includes refilling, sowing, weeding etc. and that of protective staff includes all labour engaged to protect the plot from cattle and fire damage, with all possible vigilance. For the former the expenditure comes to Rs. 15 and for the latter almost the same amount is required; the total cost works out to Rs. 30 per acre, which should give at least 100 established pasture or shady trees together with improved for age value of about the five times the original.

IMPROVEMENT FELLINGS

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What is an improvement felling ? The term itself is self explanatory as it indicates a method of fellings for the improvement of the forests. Improvement fellings are defined as the working over a forest with the object of bringing about an improvement in the general condition of the growing stock by the removal of inferior stems and species wherever this will help better stems or species.

The necessity for conducting improvement fellings is the ruinous condition of the forest due to combined action during the past of several causes such as fires, reckless and uncontrolled utilisation, grazing and lopping for fodder, shifting cultivation, and destruction in whatever form it may have occurred.

The result of all these and other causes working continuously has been that the forests, besides being extremely irregular and insufficiently stocked, contain large quantities of unsound, or mis-shapen, or unhealthy stuff and in some cases also an inadequate proportion of valuable and marketable species. In certain areas advance growth may be abundant rendering their restoration and improvement easy, in others it occurs only in patches or consists of sparsely scattered scantlings or clumps of stool shoots, the soil being too hard and under

the dominion of grass to give any chance for the spontaneous appearance or reproduction within a reasonable time. Be ween these two extremes there are intermediate stages of regeneration. According to the requirements in each case the regeneration may either be established or completed by sowing or planting and clearing away all the old stock or adopting any of the methods of natural regeneration. But if such wholesale action is not possible, all unsound, deteriorating, knotty, inferior and harmful trees have to be removed as quickly as practicable, while at the same time adopting such means in order to obtain as full a crop as possible composed of healthy trees of valuable species.

Thus it is a special kind of operation combining in itself the attributes and objects of every kind of felling namely the preparatory felling, thinning, cleaning, afterfelling or the seeding felling. However, in mixed forests a proper distribution of the component species should not be lost sight of. The realisation of revenue is never considered as one of its objects and any return from the material removed being entirely incidental. In fact it is too big to be called a silvicultural operation and too little to be styled a silvicultural system. Compared with selection thinnings, there is no sharp line of distinction between the two but improvement fellings cover a period during which a hitherto badly treated forest is aimed at bringing to a good condition by allowing a period of rest in order to restore the forest capital which has been encroached upon and to render the forest fit for regular working by a more intensive system. Improvement fellings are often combined with selection system, namely selection-cum-improvement fellings where an exploitable size is fixed for such sound and mature trees as may be found and improvement fellings carried out through the rest of the crop. But where the past treatment has been hopelessly bad, it is adopted as a temporary system. In this the fellings proceed over the area in accordance with a prescribed felling cycle and consist of :

1. Felling utilisable dry trees.
2. Felling unsound or badly shaped mature or immature trees where their removal will *benefit other* better growth.
3. Felling unsound, overmature, trees that are unlikely to survive or which may further deteriorate before the next felling, unless they are required to cover the soil or for seed.
4. Thinning out crowded groups of trees in young age classes.
5. Cutting back badly shaped or injured saplings and advance growth from which better new coppice shoots can be expected.
6. Removal of undesirable undergrowth preventing or likely to prevent regenaration.
7. Climber cutting.
8. Removal of diseased, and fig or *loranthus* attacked trees.

In marking trees sufficient care has to be taken to induce conditions suitable for regeneration where absent. In carrying out the above principles, if the management is highly skilled and sufficient care be taken to secure regeneration, excellent results may be obtained, but if no thought is taken for regeneration, and the management is not skilled or if it lacks continuity, the results may be far from satisfactory. Indeed, marking for fellings involves greater financial responsibility but marking for improvement fellings calls for far greater skill.